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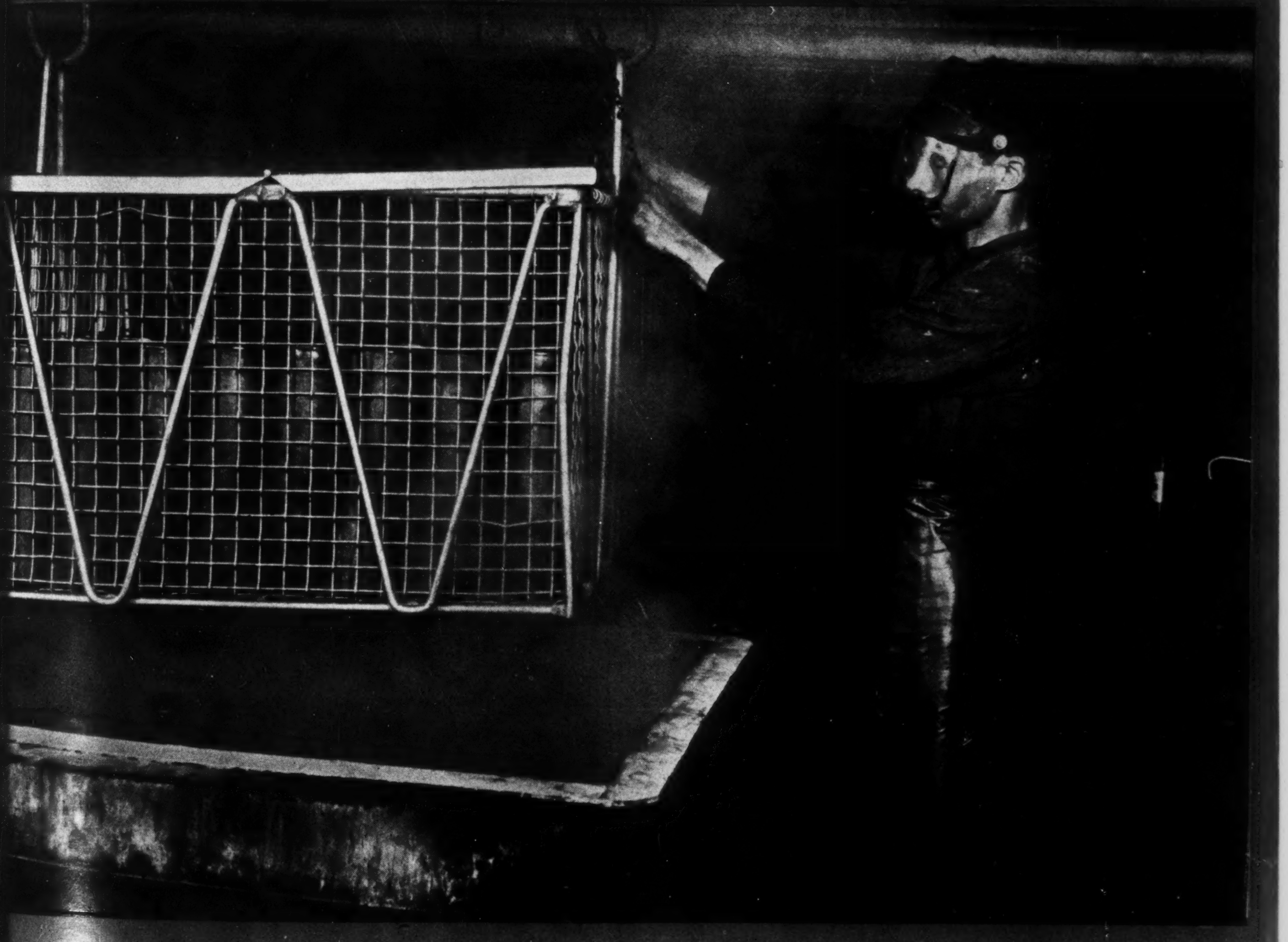
e 275 — *Journal Section of the American Society of Heating and Ventilating Engineers*



HOW TO design ventilating systems for finishing tanks is the subject of Allen D. Brandt's article

CONTENTS . . PAGE 67

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THE *Editor's Pages*

Do you ever feel like writing a "letter to the editor"? We hope that sometimes you do, and the next time this sensation creeps over you that you'll do something about it. His address is 6 N. Michigan Ave., Chicago 2, Ill. . . . We like comment on articles you do and don't like, suggestions for subjects, kicks or bouquets. What article is the best this month? Which is the worst? . . . Write us today.

REPORTS LARGE POSTWAR CONSTRUCTION DEMAND

Mounting evidence of postwar construction demand is seen in statistics on postwar projects released last month by the F. W. Dodge Corp. Up to March 31, 90,700 specific projects contemplated for postwar execution had been reported by the corporation's field staff, the estimated total cost of the projects being $14,815,613,000. These projects were reported for the territory east of the Rocky Mountains, and consequently do not fully measure the potential postwar volume for the whole country.

Of more immediate significance is the fact that 30,217 of these projects, amounting to $7,231,295,000, have progressed to the design stage, representing more nearly the volume of work likely to be ready for bids within a reasonable time after wartime restrictions are lifted. This volume of postwar planned work is measurably greater than the total volume of contracted work in the 37 eastern states for any previous peacetime year.

Commenting on these figures, Thomas S. Holden, president of F. W. Dodge Corp., said: "Any delays in postwar construction revival will definitely be due to temporary material and manpower shortages rather than to any lack of demand or to dearth of planned projects. Our recorded figures include no deferred repair, maintenance, and modernization projects, demand for which will be very heavy. They include only moderate amounts of such small new private building projects as are not usually planned much in advance of actual work. While our tabulation is definitely overweighted with public projects which may take some time for adequate financing, the $2,379,518,000 of new private projects in the design stage is considerably greater than the actual volume of private work in the 37 states contracted for in any of the prewar years, 1937, 1938, or 1939."

Substantial increase in construction volume in the 37 states east of the Rockies during the first quarter of 1945 as compared with the similar period of last year was also reported by Dodge. The volume totaled $616,780,000 as compared with $472,867,000 in the first quarter of 1944. The main increase in activity was in nonresidential construction, especially buildings used for manufacturing purposes.

1945 MARKS WELDING ANNIVERSARY

According to Oxy-Acetylene Tips, publication of the Linde Air Products Co., the year 1945 marks the 50th anniversary of the discovery of the oxy-acetylene flame. It was in 1895 that the French chemist, Le Chatelier, discovered that the combustion of acetylene with oxygen produced a flame having a higher temperature than that of any gas flame previously known. This and other early discoveries paved the way for making oxy-acetylene processes the "universal tool of all industry."

JET ENGINE WARMS PLANE'S CABIN

The new "G-E Jet," said to be the most powerful aircraft engine in the world, feeds warm air to the pressurized cabin of the Army Air Forces Lockheed P-80 in addition to carrying out its major operation of driving this propellerless fighter faster than any other plane will fly, it has been disclosed by the General Electric Co.

The air flows from the impeller-compressor of the jet engine into the enclosed cabin. Temperature of the air is controlled, making it unnecessary for the pilot to be swathed in heavy clothing. The pressurization of the cabin also makes it possible for the pilot to breathe normally at altitudes of six miles and more without even wearing an oxygen mask.

The actual functioning of the jet engine is simple. Air rams into vents in the front of the plane's wings, almost flush against the fuselage. It funnels to the engine, where it is compressed by a swiftly revolving impeller. The air is whipped by the impeller to a combustion chamber, where fuel (usually kerosene) burns fiercely.

The air expands and increases in velocity. The air and gases then pass through a turbine wheel, which is connected by shaft with the impeller. This turbine spins thousands of times a minute at temperatures of 1500 F and hotter. The blast passes out of the jet exhaust at the rear tip of the plane, giving the forward thrust.

A. C. REQUIRES MUCH CITY WATER

Industrial progress is presenting a new demand for additional large quantities of water to the Chicago water supply system, according to Loran D. Gayton assistant city engineer, in a paper recently given before the Western Society of Engineers. This new demand is for water in connection with air conditioning equipment. Prior to 1930 air conditioning had been a minor factor in water supply demand. However, in the last few years this industry has made rapid progress and now shows considerable acceleration in the rate of increase.

Air conditioning affects the demand on a water supply system principally through the refrigeration or cooling of air which is but one function of air conditioning in general. The demand for air cooling occurs during the summer months and the higher the temperature the greater the demand, and unfortunately this air cooling demand period coincides with the maximum demand from other

THE *Editor's Pages*

sources. The air cooling and refrigeration demand added to the normal peak of water pumpage represents a direct increase in the required capacity of the system.

RESTRICTIONS REMOVED ON PIPE COVERING

Eighty-five per cent magnesia pipe covering has been removed from the Army and Navy munitions board's revised list of prohibited items for construction work, according to the Magnesia Insulation Manufacturers Association. The new list, dated March 10, but just released, contains no restrictions on magnesia.

This removes the final barrier to full use of the product by industry, the former WPB restriction having been deleted in November 1943, says the association.

The munitions board restriction prohibited the use of 85 per cent magnesia in installations where operating temperatures were under 212 F, except on installations buried in the ground.

STORES SHOW GROWING INTEREST IN A. C.

A projection based upon the returns from a questionnaire on proposed postwar expenditures for store modernization and improvements sent by the National Retail Dry Goods Association's postwar planning committee to the association's members indicates that something upward of a billion dollars will be spent for these purposes shortly after the ending of the war.

The survey indicates that the largest expenditures under contemplation by retailers will be for additions to or expansion of plant. The figures show that 30.9 per cent of the total planned spending will be for this item. The report indicates a growing interest in air conditioning, upon which the stores plan to spend 6.2 per cent of their funds available for modernization purposes.

ANNOUNCES EDUCATIONAL PROGRAM ON CONTROLS

A large educational program for the heating industry got under way in Chicago and New York last month when the Minneapolis-Honeywell Regulator Co. lifted the curtain on what promises to be a nationwide school for virtually every individual associated with automatic heating. In preparation for more than a year, the "school" will be open to dealers, wholesalers, manufacturers, vocational schools, electricians, steamfitters, sheet metal workers and any others interested in heating.

The courses will be held in all sections of the United States where company branches are maintained, and when a sufficient number of people indicate a desire to enroll. Prepared by technicians in cooperation with a company specializing in visual education, the complete course extends for four 2½ hr meetings.

Primary purpose of the program is to teach the application of automatic controls and their installation and maintenance in connection with all types of heating systems using all kinds of fuel. The information to be covered has been divided into 19 subjects with plans to cover several phases in each meeting. Subjects to be discussed include control identification, circuits, thermostats, thermostat installation, limit controls, relays, controls for oil burners, summer-winter systems, oil burner systems, gas burner control systems, stoker systems, hand fired systems, unit heater systems, zone controls, installation helps and service tips, etc.

MONKEY CLEANS AIR DUCTS

This monkey is an expert cleaner of ventilation systems, according to its owner, Steve Ely. Here is how the monkey man, as he calls himself, says it is done: Ely inserts the monk into an opening in a small duct. Attached to the animal are wire brushes which he drags along the duct to a second opening on a lower floor. The monkey then returns to the top, Ely says, and makes a second trip through the duct with a small vacuum cleaner, picking up most of the soot and dust loosened by the brushes. Here the monkey is shown getting a breath of air after starting the job of cleaning out ducts at a Kansas City courthouse. (Acme photo.)

Heating Piping & Air Conditioning

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CONTENTS THIS MONTH

May 1945 **Vol. 17, No. 5**

The Editor's Pages (news and comment) .... front section 63

Ventilation of Finishing Tanks—a Correlation of Existing Data, by Allen D. Brandt 237

Welding Fumes a Problem: Underground Ducts Supply Heated Air to Floor Level Grilles at Big Plant, by H. K. Hicks 243

Sam Lewis' Page—Automatic Temperature Regulation Is Essential in School Buildings 246

Practical Pointers on Operation, Maintenance, Repair, Alteration, Extension 247

How Much Fuel Does Building Insulation Save?, by Frank B. Rowley and Richard C. Jordan 247

Central Refrigeration for Air Conditioning—a comment by O. W. Ott 249

The Adventures of a Pound of Steam . . . 3, by A. C. Kirkwood 250

Air Conditioning Speeds Output in Bearing Industry 251

Saving Fuel—and Dollars—in Laundry Operation, by Harold M. Toombs 252

Drawing and Imagination, by V. L. Sherman 254

Comparative Engineering Data on Refrigerants Given in New Tables 256

Background for Research: South Pacific, by F. W. Hutchinson 259

Survey of Air Conditioning "Troubles" Would Be Valuable—suggestion by O. W. Ott 261

Using the Velocity Head Concept in Pressure Drop Calculations, by C. E. Lapple 262

Abstracts of Enemy Patents Available 267

Asks Better Heating, Ventilating in Foundries 267

WPB . . . OPA . . . PAW . . . Etc. (new government orders) 268

"Open for Discussion" 271

Backing Rings for Welded Piping, by D. H. Corey 271

How Should We Control Schoolroom Temperature?, by John Howatt 271

It's Not the Heat Pump, Professor Tucker!, by Carl F. Boester 272

Equipment Developments .... back section 187

Recent Trade Literature .... back section 204

New Books & Reports .... back section 216

Meetings & Conventions .... back section 222

Index to Advertisers .... back section 228

Journal Section of the American Society of Heating and Ventilating Engineers

Mine Ventilation and Its Relation to Health and Safety, by D. Harrington 275

Principles of Ultraviolet Disinfection of Enclosed Spaces, by L. J. Buttolph 282

Laboratory Studies—Air Duct Friction 291

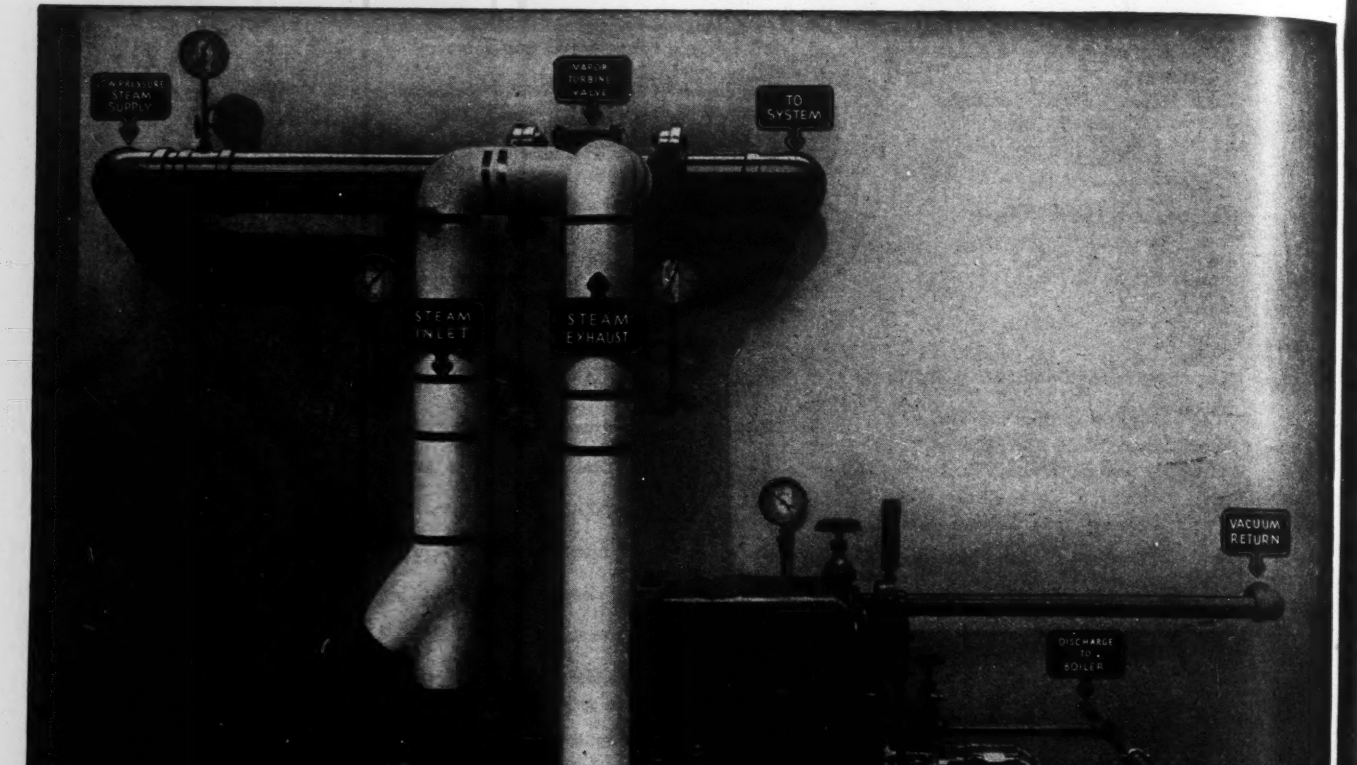
Summary of Local Chapter Meetings 294

Candidates for Membership 297

Candidates Elected 299

Officers, Council, and Committees 303

Interrupted Electric Service will not stop this NASH Heating Pump!



In Hospitals, Greenhouses, Schools, Public Buildings, Theatres, wherever heating systems must not fail, install the Nash Vapor Turbine, for it is independent of electric current failure, and continues to operate as long as there is steam in the system.

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VENTILATION OF FINISHING TANKS

A Correlation of Existing Data

By Allen D. Brandt, Sc.D.
Senior Sanitary Engineer, U. S. Public Health Service
Safety and Security Division, Army Service Forces

Much has been written in recent years regarding the need for and the design of ventilating systems for finishing tanks such as plating, pickling, degreasing, Parkerizing, anodizing, and caustic cleaning tanks. Even though all these studies had the same or very similar objectives, they were carried out in different manner and the results or conclusions were expressed in sufficiently unlike terms that they have confused completely many of the engineers whose task it is to design these ventilating systems. It has become necessary, therefore, to digest the findings as reported in these studies so that they may all be reported in a standard manner which will make them understandable to and usable by those engineers who are not specialists in the field of industrial hygiene engineering but who are called upon to design such systems. No attempt is made in this paper to cover all the reports on this subject. The findings of enough reports, particularly the more recent and more important ones, are analyzed to indicate that they are comparable for the most part—the apparent difference in results being largely one of method of expression.

In 1928 Bloomfield and Blum (Reference 1) made a study of the health hazards associated with chrome plating operations, and measures for the control of such hazards. They studied a variety of chrome plating tanks with and without adequate control. Even though the type and rate of ventilation employed on the tanks they encountered varied a great deal, their findings indicated and they concluded that the health hazard at chrome plating operations was controlled satisfactorily if lateral slot type exhaust ventilation was provided at a rate sufficient to produce a 2000 lfm slot velocity—the slot width to be varied with tank width and the slot velocity to be kept at 2000 lfm.

An analysis of the data given in their paper results in the following conventional type equation:

$$Q = 110LW \quad \ldots\ldots\ldots\ldots\ldots [1]$$

where Q = the required exhaust ventilation rate in cfm; L = tank length in ft; and W = tank width in ft.

By 1937 chrome plating had become very widespread so Riley and Goldman (Reference 2) made a similar study and concluded that the health hazard was controlled if lateral exhaust ventilation was provided at the plating tanks at a rate given by the following equation:

$$Q = 100LW \quad \ldots\ldots\ldots\ldots\ldots [2]$$

where Q, L, and W are the same as in Equation 1.

After careful and lengthy consideration, the American Standards Association in 1941 issued a code for safety in electroplating operations (Reference 3) in which the recommended lateral exhaust ventilation rate for chrome plating and other similarly hazardous plating operations is as follows:

$$Q = 120LW \quad \ldots\ldots\ldots\ldots\ldots [3]$$

where Q, L, and W are as given in Equation 1.

This ventilation rate was based largely on the data in References 1 and 2.

The discussions preceding the formulation of the ASA code pointed to the need for research into the fundamentals of air flow into slot type suction openings as used on tanks, and almost simultaneously (even though entirely independently), three such studies were undertaken.

Battista, Hatch, and Greenburg (Reference 4) determined the velocity contours in the plane normal to and at the midpoint of a 6 ft long slot type exhaust hood having a 1 in. slot. The hood arrangement was comparable to that in use on tanks except that there was no opposite wall at the tank (see Fig. 1). The test arrangement and the veloc-

HOW TO design ventilating systems for finishing tanks—such as plating, pickling, degreasing, Parkerizing, anodizing, and caustic cleaning tanks—is clarified in this practical article by an outstanding authority. Much has been written on the subject in recent years, but the various studies reported were carried out in different ways and the results or conclusions were expressed in sufficiently unlike terms so that they have confused completely many—if not a majority—of the engineers who must design these ventilating systems. The author therefore digests the findings of these studies and reports on them so that they will be understandable and usable to those who are not specialists in industrial hygiene engineering. He shows, too, that the apparent difference in results is largely a matter of the method of expressing them. In his conclusions, Dr. Brandt shows equations for design of ventilation for cleaning and finishing tanks, electroplating tanks, and degreasers, and points out some of the things on which more research is needed . . . The vital importance of properly designed finishing tank ventilation to production efficiency and to the health, safety, and comfort of workers is obvious to all who are familiar with manufacturing methods

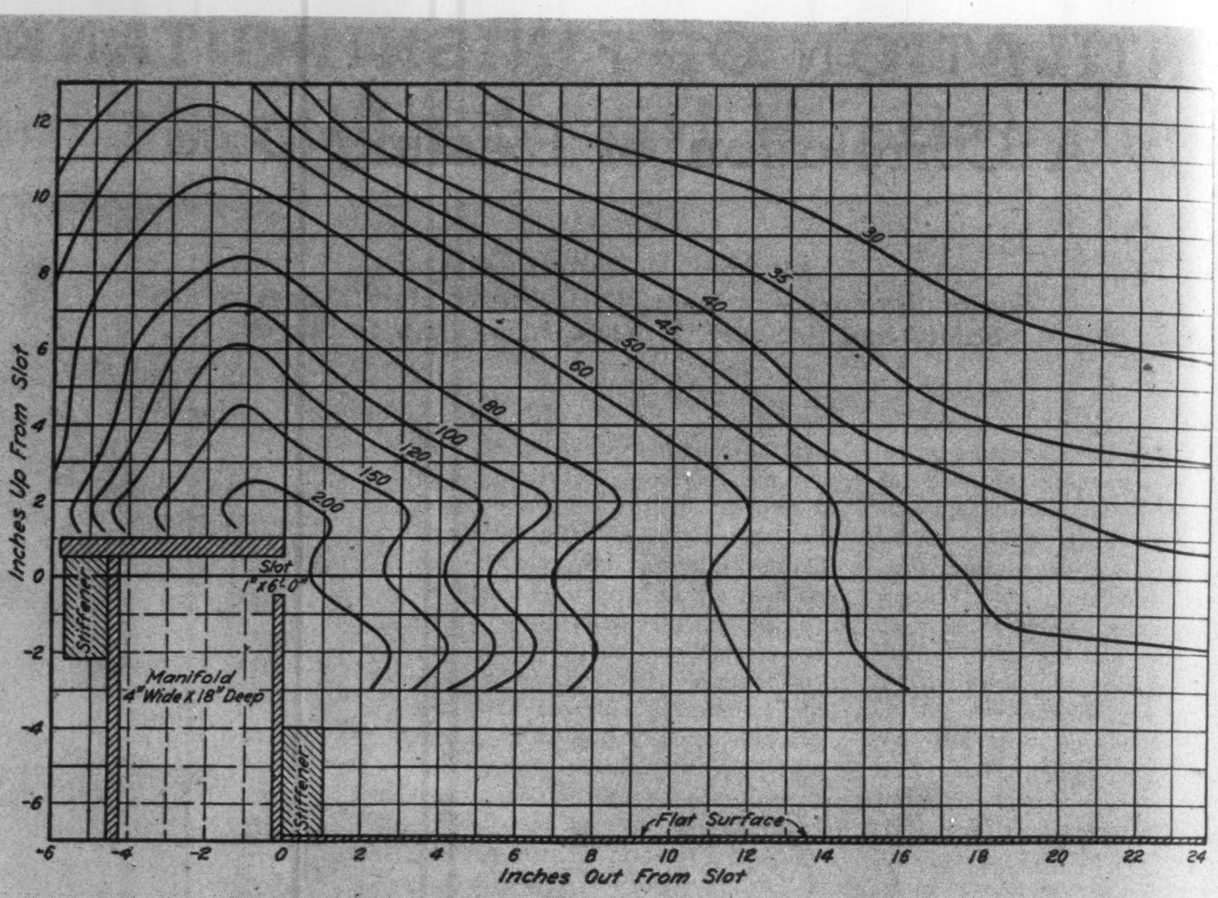


Fig. 1—Velocity contours for plating tank exhaust slot

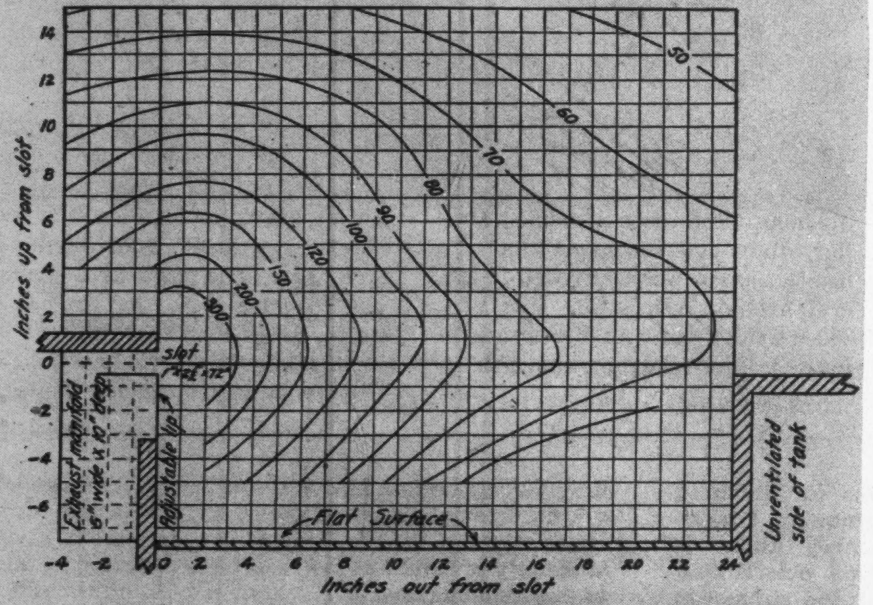


Fig. 2—Velocity contours for plating tank exhaust slot

ity contours are shown in Fig. 1. The data resulting from this study indicated that the air flow relationship in the axial line of the hood could be expressed by the following equation:

$$Q = KLW^{0.63} \quad \ldots\ldots\ldots\ldots\ldots [4]$$

where Q, L, and W are the same as in Equation 1 and K is a constant.

A liberal analysis of the data presented in their paper results in the following approximate equation expressed in a more conventional form:

$$Q = 3.0LVx \quad \ldots\ldots\ldots\ldots\ldots [5]$$

where Q = the exhaust ventilation rate in cfm; L = hood length in ft; V = air velocity in lfm at axial distance x from hood (by axial is meant on the line formed by the intersection of planes normal to each other, one the perpendicular bisector of the hood, and the other through the middle of the slot and perpendicular to the face of the hood); and x = axial distance in ft from hood where air velocity is V lfm.

The author (Reference 5) obtained very similar results in a study done at the same time but entirely independently and without

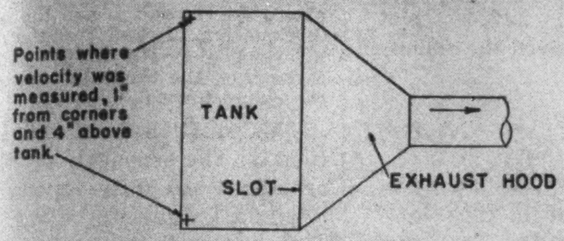
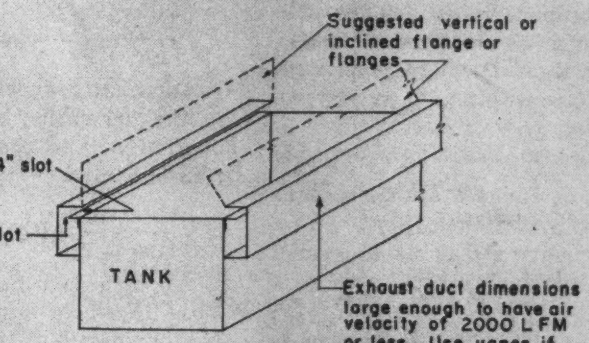

Points where velocity was measured, 1" from corners and 4" above tank.
TANK
SLOT
EXHAUST HOOD

Fig. 3—Silverman in 1941 determined the air flow relationship between Q and the velocity in remote corners of the tank

Fig. 4—Slot type exhaust hoods for tanks


Suggested vertical or inclined flange or flanges
2" to 4" slot
1" to 2" slot
TANK
Exhaust duct dimensions large enough to have air velocity of 2000 L FM or less. Use vanes if necessary to get uniform slot velocity.

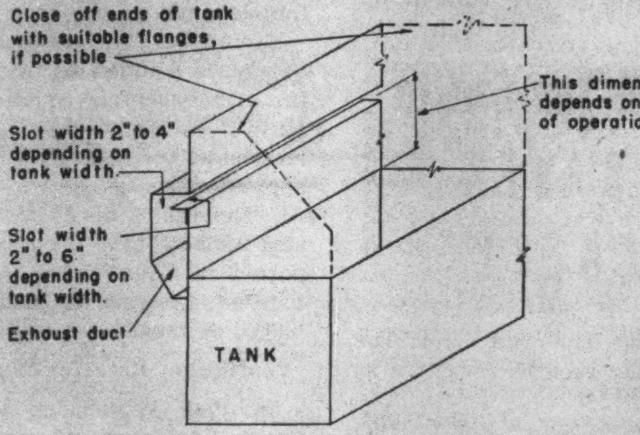

Close off ends of tank with suitable flanges, if possible
This dimension depends on nature of operation
Slot width 2" to 4" depending on tank width.
Slot width 2" to 6" depending on tank width.
Exhaust duct
TANK

Fig. 5—Exhaust hood for hot liquid tanks and similar tanks where vapors escape from parts being processed above tank top

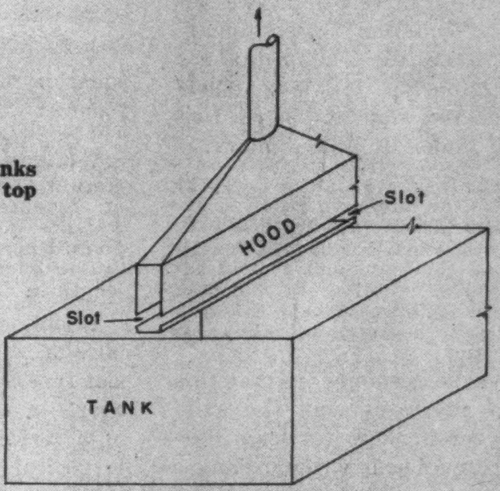

Slot
HOOD
Slot
TANK

Fig. 6—Slot type exhaust hood at middle of wide tank

any knowledge of the arrangement used in Reference 4. (See Fig. 2.)

The only significant difference from Equation 4 was that the value of the exponent of W was found to be a variable, decreasing as the distance from the slot increased and having a value of 0.50 at the far edge of a 24 in. wide tank. A further analysis of the data results in the following equation:

$$Q = 2.7LVx \quad \text{[6]}$$

where Q, L, V, and x are the same as in Equation 5.

Silverman (Reference 6) a short time later studied the velocity characteristics of narrow exhaust slots. For *unflanged freely suspended* slot hoods, he found the axial air flow relationship was as follows:

$$V = \frac{38.9Q}{xL} \quad \text{[7]}$$

where V = the velocity in lfm at axial distance x from the hood; Q = the exhaust ventilation rate in cfm; x = axial distance in *inches* from the slot to point where velocity was V lfm; and L = hood length in *inches.*

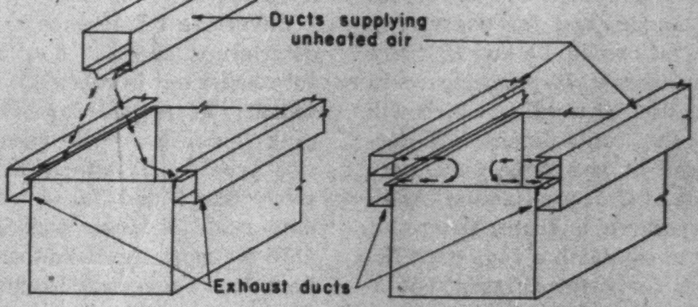

Ducts supplying unheated air
Exhaust ducts

Fig. 7—Supply and exhaust system of tank ventilation

This equation may be converted to the following:

$$Q = 3.7LVx \quad \ldots\ldots\ldots\ldots\ldots [8]$$

where Q, L, V, and x are the same as in Equation 5 above.

For flanged hoods (comparable to slot hoods as employed at tanks) he found the following air flow relationship existed:

$$V = \frac{55.4Q}{xL} \quad \ldots\ldots\ldots\ldots\ldots [9]$$

where V, Q, x, and L are the same as in Equation 7 above.

This equation may be converted to the following form:

$$Q = 2.6LVx \quad \ldots\ldots\ldots\ldots\ldots [10]$$

where Q, L, V, and x are the same as in Equation 5 above.

Thus we have the results of three independent studies which when expressed in similar form check very well (see Equations 5, 6, and 10. Equation 8 was for freely suspended unflanged slot hoods which are not comparable to hoods on tanks).

Using these three results, we can select the equation which apparently expresses the fundamental air flow relationship for long hoods having narrow slots and as used on finishing tanks. It is as follows:

$$Q = 2.8WLV \quad \ldots\ldots\ldots\ldots [11]$$

where Q = the minimum required exhaust ventilation rate in cfm; W = tank width in ft; L = tank length in ft; and V = minimum control velocity in lfm required to maintain the degree of atmospheric contamination below the maximum allowable concentration.

It must be remembered that this equation expresses only the axial air flow relationship for long, narrow slot type hoods without flanges used at tanks similar to that shown in Fig. 4. It must also be realized that this equation is useful only if the value of V is known for the operation under consideration. While the values of this factor for chrome plating can be computed from Equations 1 and 2, and for degreasing from Equations 16, 17, and 18, *there is no substitute for experience* in the selection of a value which will control the contaminant satisfactorily and at the same time keep the value of Q at a minimum. Additional research is required on this subject to establish a suggested list of values for V for different operations and for different conditions of operation.

In 1939 Dalla Valle (Reference 7) published the results of some work done earlier on the fundamentals of air flow into freely suspended, unflanged, narrow slot type hoods. He derived the following equation:

$$\frac{Y}{100 - Y} = 0.2w^{2.10}x^{-1.91} \quad \ldots [12]$$

Apparently there was an error in the derivation or in the reproduction of the results. The equation should be:

$$\frac{Y}{100 - Y} = 0.2(WL)^{1.04}x^{-1.91} \ldots [13]$$

Since the exponents are all very close to whole numbers they may be considered as such without introducing an important error. The equation may then be rewritten as follows:

Do All You Can to
SAVE
FUEL!

$$Q = V(5x^2 + wL) \quad \ldots\ldots\ldots [14]$$

where Q=exhaust ventilation rate in cfm; V = axial air velocity in lfm at distance x from hood; x = axial distance in ft from the hood to the point where the velocity is V; w = slot width in ft; and L = hood length in ft.

Equations 12, 13, and 14 are applicable only to freely suspended slot type hoods which are relatively short—a moderately extreme form of a rectangular hood rather than a typical long, narrow slot type hood at a tank. These equations are, therefore, not applicable to long hoods as commonly used on finishing tanks and *should not* be used in the computations relating to the design of local exhaust systems for such tanks.

Silverman (Reference 8) in 1941 determined the air flow relationship existing between Q and the velocity in remote corners of the tank (see Fig. 3). He used narrow slot type hoods which were relatively short and for some of his data made W larger than L. Probably the most significant difference, however, between this study and those reported in References 4, 5, and 6 was in the location of the points where V was determined. For unflanged hoods on tanks he derived the following equation:

$$Q = 2.3W^{1.15}L^{0.85}\ V \quad \ldots\ldots\ldots [15]$$

where Q, W, and L are the same as in Equation 11, and V = the average air velocity in lfm at the two upper corners of the tanks located opposite the exhaust hood.

This equation is not unlike Equation 11. The exponents of W and L are close to unity—however, the constant appears to be low. Since V was measured in the corners of the tank it is expected that the value of K would be higher than when measured axially. This low constant was probably brought about by the test arrangement, the exhaust hood serving as a horizontal flange on the hood.

A study of the data presented in Reference 8 indicates that they fit the fundamental equation $Q = KLWV$ if the value of K is increased as the ratio L/W decreases approximately as shown in Table 1. The values of K in this table also indicate that the constant reported in Equation 15 is low for exhaust systems as usually employed on tanks.

Ventilation Rate for Degreasers

In 1940 Witheridge and Walworth (Reference 9) reported the findings of an investigation into the preferred type of hood design and minimum ventilation rate required to control the health hazard at a trichlorethylene degreaser. Their data indicate that slot type exhaust hoods along the top perimeter of the tank with an exhaust ventilation rate of 30 cfm per sq ft of tank area kept the atmospheric concentration of trichlorethylene vapors considerably below the maximum allowable concentration. Thus, their recommended exhaust ventilation rate for degreasers is as follows:

$$Q = 30LW \quad \ldots\ldots\ldots\ldots\ldots [16]$$

where Q, L, and W are the same as in Equation 1.

It will be noted that Equation 16 is similar to those reported for electroplating except that the constant is much smaller. Obviously, the higher constant as found necessary for plating would provide adequate control but it results in an unnecessarily high exhaust ventilation rate, and what is more important, it results in excessive solvent loss—a factor which need not be considered at plating operations but which must never be

Table 1—Value of K in fundamental equation *($Q = KLWV$)* for different values of *L/W* to fit equation 15

	K	
L/W	Unflanged hood*	Flanged hood†
1	2.3	1.9
1.5	2.2	1.7
2	2.1	1.55
2.5	2.0	1.45
3	1.95	1.35
4	1.85	1.25
5	1.8	1.15
6	1.75	1.1

*Hood not provided with special flange but the hood itself was of such design that it acted as a flange permitting air to enter central portion of hood through only a 180 deg. sector.

†Flange provided at hood so that air entered central portion of hood through only a 90 deg sector.

ignored at degreasing operations.

The results reported in References 9 and 10 led the author (Reference 11) to suggest the following equation for degreasing tanks:

$Q = 50LW$ ....[17]

where Q, L, and W are the same as in Equation 1.

Even though the ventilation rate prescribed by Equation 17 is almost twice that found adequate by Witheridge and Walworth it was felt advisable since many degreasing tanks have hoods on only one or both long sides—not around the entire perimeter—and the solvent loss is not excessive if the degreaser is of good design.

A little later, Morse and Goldberg (Reference 12) reported on a thorough study of exposures at degreaser operations and suitable control measures. They concluded that where local exhaust ventilation was needed, an exhaust ventilation rate as given by the following equation controlled the exposures adequately in most instances:

$Q = 35LW$ ....[18]

It is apparent, therefore, that an equation of the following general form has been found to best express the required ventilation rates for local exhaust hoods of the slot variety for finishing and cleaning tanks of all kinds:

$Q = KLWV$ ....[19]

where Q = required local exhaust ventilation rate in cfm; K = a constant which will vary with the hood design and location; L = tank length in ft; W = tank width in ft; and V = minimum axial control velocity at point most remote from hood or hoods.

Possibly some variation of this equation similar to that of [15] might express the air flow relationship more accurately. However, the simple Equation 19 with but minor modifications as given in Equations 1, 2, 3, 5, 6, 10, 16, 17, and 18 has been found entirely satisfactory in practice and has stood the test of time. Future research in this connection should be directed toward establishing values for V for different operations and for K for different hood arrangements.

As indicated in Reference 13, the value of K may vary from as little as less than 1 to about 5 or 6, depending upon the nature of the barriers, shields, or flanges which influence the air flow into the slot hood. Some work is needed to establish the proper value for different typical arrangements. Likewise, Equations 3 and 17 indicate that the minimum control velocity varies with the type of operation. These equations, for example, show that the required minimum control velocity for the safe operation of plating tanks is about 43 lfm and of degreasers is about 14 lfm. Research is needed to determine whether 43 lfm is adequate for all plating operations or whether high current density plating needs a considerably higher rate, and vice versa; also, to determine satisfactory values of V for hot rinsing, cleaning, or finishing tanks.

The low values of V reported above for plating and degreasing tanks are frequently misleading. These are the values of V existing at the midpoint of the top edge of the tank opposite the hood for tanks with a hood along one long side, and in the center of the top surface of the tank for tanks having hoods along two long sides or along the entire perimeter. The average velocity in the zone of contaminant escape is twice the minimum control velocity and the amount of material escaping into the air from the remote sections of the tank where the control is not fully effective is not sufficient to contaminate the air in excess of the safe level.

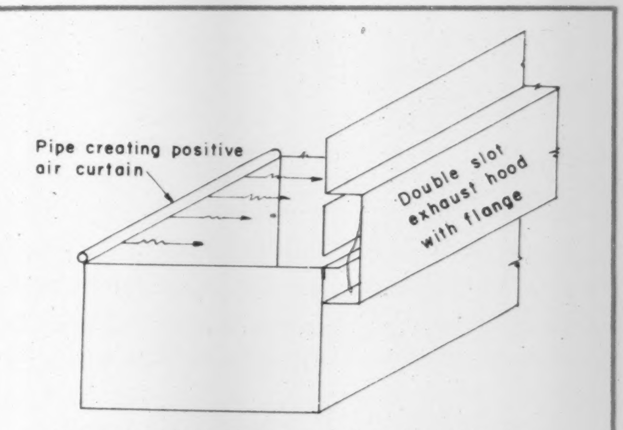

Pipe creating positive air curtain
Double slot exhaust hood with flange

Fig. 8—Push-pull system of tank ventilation

Typical slot type exhaust hood designs for tanks are shown in Figs. 4, 5, and 6.

Points to Remember

In addition to the foregoing data on exhaust system design the following points should be borne in mind by all engineers called upon to design exhaust systems for finishing tanks:

1) Not infrequently, the processed parts are withdrawn from the finishing tank while still wet and moved to a nearby station to dry. This is particularly true for paint dipping, Parkerizing, and some other finishing operations—and sometimes for degreasing operations. In such cases satisfactory tank ventilation only is not enough—provision must be made to remove the vapors liberated beyond the zone of influence of the tank ventilating system. For this purpose, downdraft tables adjacent to the tanks, exhaust ventilated tunnels leading from the tanks, or nearby exhaust ventilated enclosures are needed to prevent excessive atmospheric contamination (see Reference 14).

2) Where a number of exhaust ventilated tanks are in operation in a small or confined area, a serious heating problem may arise, particularly in cold climates. An aid in the solution of the heating

Summary and Conclusions

1) Considerable research has been done on the nature of air flow into narrow slot type suction openings and the design of exhaust ventilating systems for cleaning and finishing tanks. When expressed in similar manner, the results of these studies agree remarkably well and indicate that the air flow relationship into narrow slot suction openings is defined by the following equation:

$Q = KLWV$ ....[20]

where Q = the exhaust ventilation rate in cfm; K = a constant which depends upon the hood design and location (it is about 2.8 for unflanged narrow slot type hoods located at the upper edge of tanks); L = hood (or tank) length in ft; W = axial distance in ft from hood to point where velocity is V, (or tank width); and V = air velocity in lfm at an axial distance of W from the hood (or minimum control velocity).

2) For electroplating operations it has been found that good control of the health hazard is accomplished if the product of K and V in Equation 20 is 120. Hence, for plating operations the recommended minimum ventilation rate is:

$Q = 120LW$ ....[21]

where Q = exhaust ventilation rate in cfm, and L and W = tank length and width in ft, respectively.

3) For well designed and carefully operated degreasers it has been found that the health hazard is controlled satisfactorily if the degreaser is exhaust ventilated at a rate of about 30 to 40 cfm per sq ft of tank area. Since this is a very low ventilation rate, and to provide a small margin of safety for bad design or careless operation, the recommended minimum ventilation rate is expressed by the following equation:

$Q = 50LW$ ....[22]

where Q, L, and W are the same as in Equation 21.

4) In the field of local exhaust ventilation for cleaning and finishing tanks research is needed on values of K in Equation 20 for different narrow slot hood designs and location; values of V in Equation 20 for different operations; and the fundamentals of air movement by "push-pull" systems.

problem is to provide part of the makeup air by supplying untempered air, if practicable, in the vicinity of air removal (see Fig. 7) so that only part of the air exhausted is taken from the room (Reference 15).

3) For wide tanks where an exhaust hood can be provided along only one long side, consideration should be given to the use of a "push-pull" system (see Fig. 8). Little fundamental research has been done on this subject and consequently there appears to be no standard basis for the design of such systems. However, several installations which have proved satisfactory have been reported, the most recent of which may be found in Reference 16. In this instance the positive air curtain was created by means of air from a 1½ to 2 in. diameter pipe located along one long side of the tank. On the side of the pipe facing the exhaust hood on the opposite side of the tank were 5/32 in. to 3/16 in. diameter holes spaced 2 in. to 2½ in. on center. The air pressure in the pipe was maintained at about 7 in. of water. The air was supplied to the pipe by means of a separate air system. The rate of air supply was about 8 cfm per ft of tank length for tanks about 5 ft wide. With this arrangement and a double slot exhaust hood along the tank opposite the supply pipe, it was found that for wide tanks an exhaust ventilation rate of 90 to 140 cfm per sq ft of tank area gave better results than an exhaust system alone at 200 to 250 cfm per sq ft of tank area.

Research is needed on "push-pull" systems to establish definite bases from which a satisfactory and efficient system of this type may be designed for operations on which such systems would be advantageous.

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WELDING FUMES A PROBLEM

Underground Ducts Supply Heated Air to Floor Level Grilles at Big Plant

H. K. HICKS, engineer with the Dravo Corp., describes the heating and ventilating scheme used to solve the problem of removing fumes from arc welding operations in the 150 by 300 ft welding section in the center of a large shop measuring some 700 by 200 ft. Tempered air from underground ducts is introduced through a series of grilles located at the floor, and the air is pulled upward—carrying the fumes with it—by motor driven roof ventilators. Natural gas, burned directly in the air stream, heats the air, and the control arrangement provides for from 3 to 100 per cent of capacity. The shop area surrounding the welding section is heated by eight direct fired, 100 per cent recirculating heaters

In designing a new diesel engine frame fabricating shop for an important eastern plant, the heating and ventilating problem was to provide a system which would effectively remove the obnoxious fumes from a large number of arc welders in an area 150 by 300 ft. This welding section is more or less in the center of a large shop measuring 700 by 200 ft, and because of production reasons it was considered impractical to partition it off from the main shop area. To complicate the ventilating problem further, the presence on the floor throughout the welding area of large work racks, machine tools, etc., made it necessary to provide air at or close to the floor at a multiplicity of points within the area. The obstructions would not allow the air to be thrown effectively for any great distance.

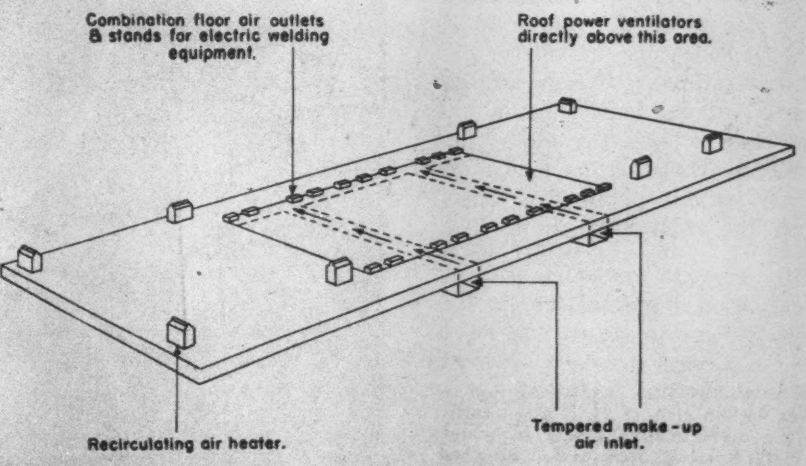
On the basis of air sampling tests made in this company's existing shops, it was estimated that 368,000 cfm of tempered air would be required in the welding area. To introduce this large amount of air without drafts, the engineers provided an underground duct system feeding a series of grilles located at the floor along the center lines of two rows of building columns, and arranged to supply tempered air at low velocity over the entire floor of the welding area. This air is then pulled upward, carrying the fumes with it, by motor driven roof ventilators.

The air is brought into the tunnel system through two fan rooms, each containing four 48 in. axial flow fans, each of which is driven through a v belt drive by a 20 hp motor. Each fan is designed to deliver 46,000 cfm of 70 F air. The fans are mounted in a vertical plane, two over the other two. In each of the two ventilating systems, the outside air, before entering the fans, passes through a duct type gas fired heater which heats the air to a temperature of 70 F. The maximum capacity of each of the two heaters is 16,000,000 Btu per hr.

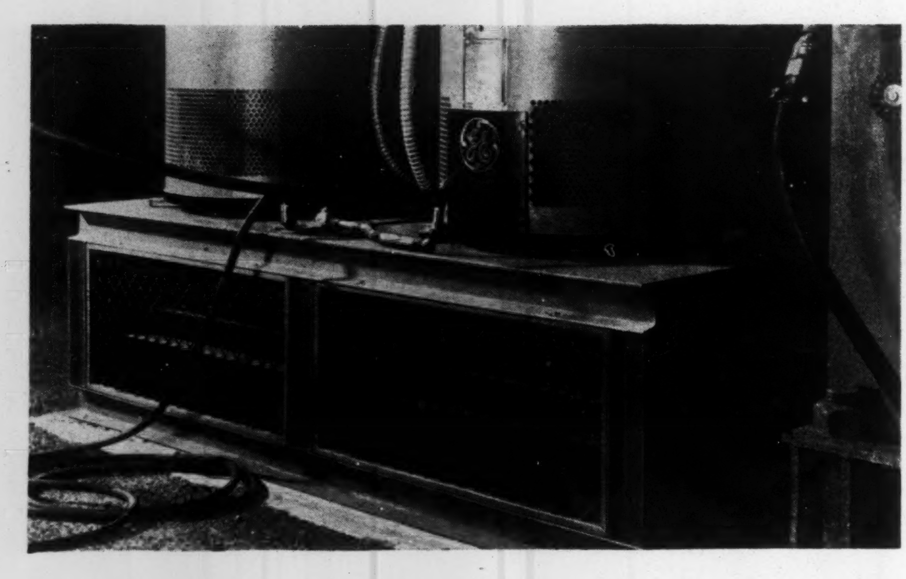
Natural gas is burned directly in the air stream in premix burners. Because the products of combustion mix with the heated air, no heat transfer surface is required, and all of the available heat in the fuel is used. The absence of heating surface provides for a negligible friction loss of the air passing through the heater, and makes possible the use of propeller type fans. The entire heating equipment, including the fans, occupies two rooms measuring 20 ft by 27 ft by 13 ft each.

Air Supply Temperature Held to Close Limits

A major requirement of the ventilating system was that regardless of the outside temperature, air entering the shop through the grilles at the floor should be held within close limits to a temperature of 70 F, provided of course the temperature outside was less than 70 F. Since men work, in some cases, very close to the grilles, a temperature less than this would be objectionable. Excess temperature would be wasteful of fuel and would cause the air to rise too rap-


Combination floor air outlets & stands for electric welding equipment.
Roof power ventilators directly above this area.
Recirculating air heater.
Tempered make-up air inlet.

Tempered air is supplied the welding section in the center of a large shop through grilles at the floor level, in order to remove fumes from a number of arc welders. The rest of the shop is heated by eight recirculating air heaters, each of which has a capacity of 1,250,000 Btu per hr



One of the floor outlets for the tempered air supply; there is a similar opening on the other side. To save floor space, electrical equipment for the welding operation is mounted on top of air outlet

idly, thus interfering with the proper ventilation.

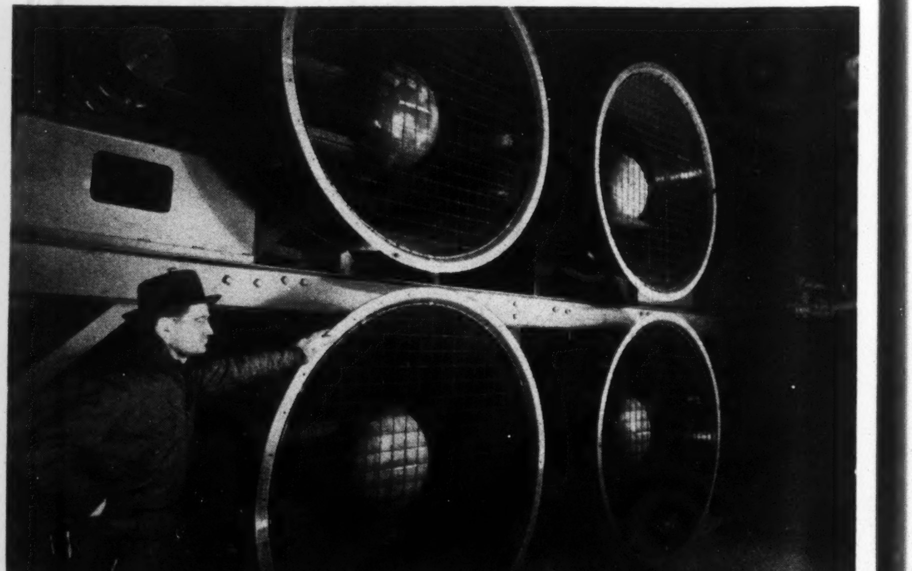
It is possible to modulate the amount of gas burned in the type of burner used to about one-third its full capacity by reducing the pressure of the gas supply. Below this amount, the flame becomes unstable. Since a two-thirds reduction in capacity would cause overheating whenever the outside temperature exceeded approximately 47 F, it was necessary to provide means of accurately controlling the amount of gas burned, even though the system would be operating at an output considerably less than one-third full capacity. The system finally devised is designed to control accurately within a range of from 3 per cent to 100 per cent of full capacity, which allows the temperature of the air delivered to the shop to be held to 70 F, even though the outside temperature should rise to 68 F. Above 68 F outside temperature, the entire gas burning equipment, except for the pilots, is automatically shut off.

The control panel for one of the two identical systems is shown in an accompanying photo. The panels are on the shop floor level. The center instrument is a combination recording meter (recording outside temperature and tunnel temperature) and controller.

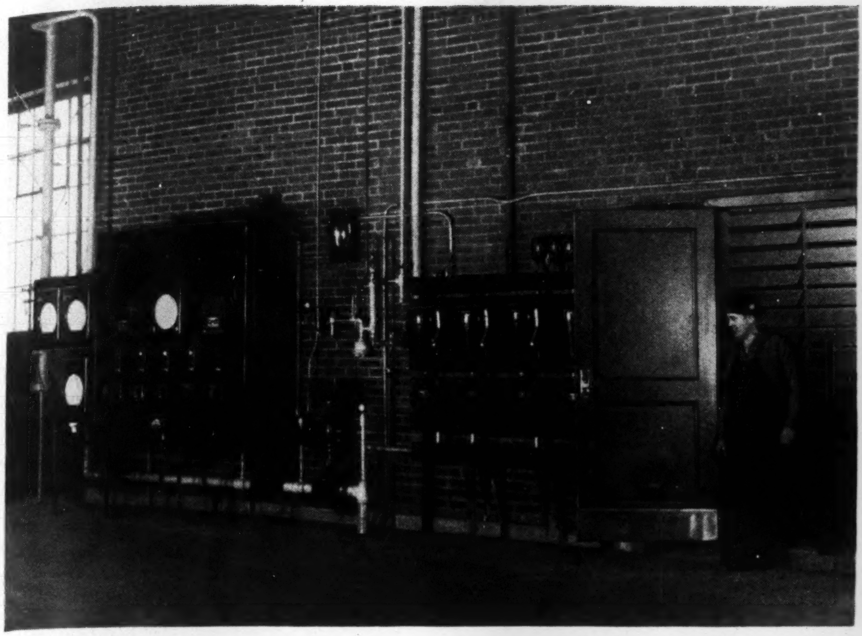
The Control Sequence

For the sake of illustrating the control sequence, assume that the outside temperature gradually rises from 0 F to 68 F. The control throttles the main gas flow to the burners until approximately 50 per cent of full capacity and then cuts off in sequence pairs of burners until one pair only remains. There are seven pairs of burners, each pair having one solenoid valve except for the last two burners, which have individual solenoid valves. For simplification of this discussion, it can be assumed, since there are seven pairs of equally sized burners, that each pair is capable of producing a 10 deg temperature rise. Each of the last two burners is individually controlled so that a 5 deg rise is produced by each of these burners when they are operated at full capacity. By throttling the flow to the last burner to 40 per cent of maximum, a 2 deg rise is obtained. Thus, by a combination of throttling and cutting off burners, it is possible to produce a final temperature of 70 F over the entire range of outside temperatures, from 0 F to 68 F.

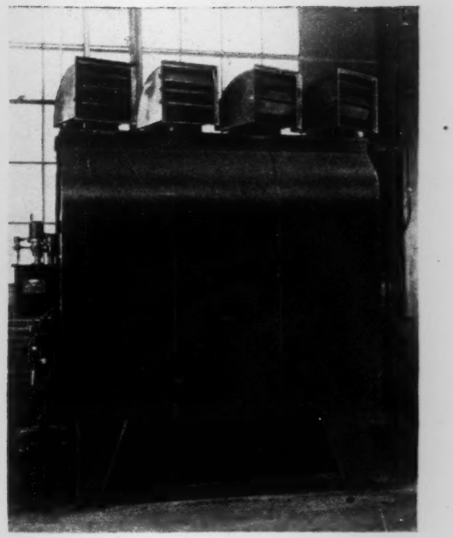
The individual burners are ignited by pilots mounted vertically at the ends of the main burners. The pilots are electrically ignited by pushbutton control from the panels and are arranged for constant burning as long as the system is in operation. However, before the pilots can be lighted, at least two of the fans must have been in operation for approximately 1 min to purge the heater room. Once in operation, the pilots and main burners continue to burn at a rate determined by the outside temperature, as previously discussed. The



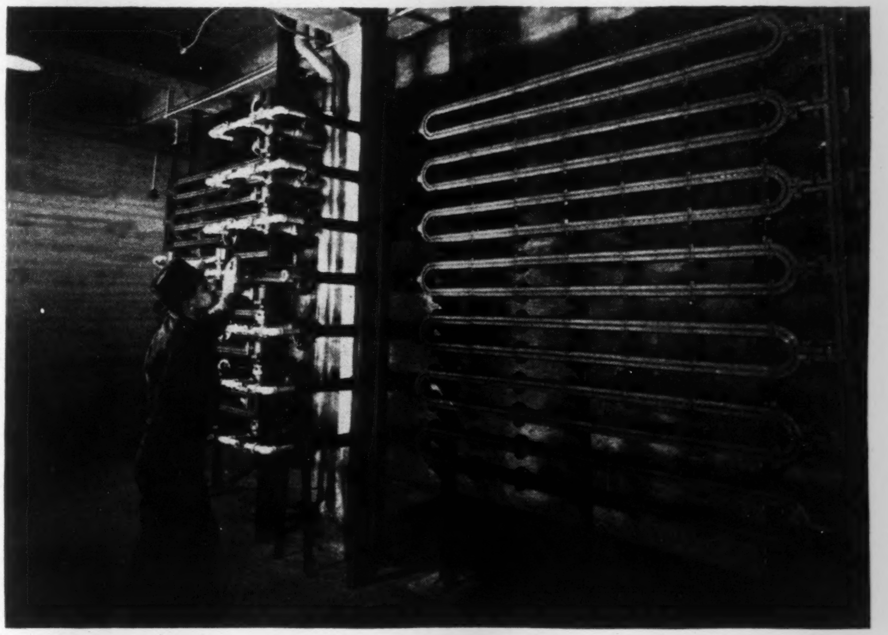
Eight axial flow fans, each designed to deliver 46,000 cfm of 70 F air, supply the two underground ducts to which the floor level grilles are connected



The control panel for one of the two identical tempered air systems. The center instrument is a combination recording meter (recording outside temperature and tunnel temperature) and controller. Lamps show operation



Eight of these direct fired heaters supply 100 per cent recirculated air to shop surrounding welding section



Natural gas is burned directly in the air stream in these premix burners, the products of combustion mixing with the heated air. Thus, no heat transfer surface is required for this

entire gas burning system will automatically shut down in the event of any one of the following possibilities: pilot flame failure, low gas pressure, power failure, fan motor failure (provided the number of fans continuing in operation is less than two), excess tunnel temperature, and outside temperature in excess of 68 F. Telltale lamps on the panel board indicate that the gas burning system is functioning, and also show the number of fans in operation.

The ratio of the air to be heated to the products of combustion is over 50 to one to preclude the possibility of exceeding the allowable concentration of carbon monoxide. It is possible that the carbon dioxide content of the air leaving the heater may reach 0.2 per cent. The presence of this gas is not harmful, however, if its concentration is kept within safe limits. A 2.0 per cent content of carbon dioxide is regarded as an entirely safe concentration and, in some cases, the presence of 4.0 per cent will produce no harmful results.

Heating the Rest of the Building

Because of the large amount of tempered air introduced, no supplementary heating equipment is provided for the welding area. The rest of the building is heated by eight conventional 1,250,000 Btu per hr gas fired heaters. These units are arranged for constant fan operation with the burners automatically controlled by thermostats located on the panel boards at the end of each heater. Pushbutton controlled electric sparkplugs ignite the pilots, and should the pilots fail for any reason, the main gas supply is automatically and instantly shut off. Each heater is further equipped with a purge timer which prevents the spark or the gas to be turned on until the main fans and the induced draft fan have operated for at least 1 min. As on the ventilating system burners, gas is shut off automatically in the event of low gas pressure, power failure, or excess heater temperature.

The engineers for this system were Day & Zimmerman.

* * *

Control of the air in industry helps to win the battle of production. Air conditioning is an important industrial tool.

Sam Lewis' Page

AUTOMATIC TEMPERATURE REGULATION IS ESSENTIAL IN SCHOOL BUILDINGS

ANYONE WHO has operated over many years throughout various states will remember that New York was among the first to enact and to enforce compulsory ventilation for schools and similar public buildings.

Recently these laws were repealed and no substitute seems to have been provided. It is reported that the great swing so often observed in human judgment has brought about a revulsion to the extent that in New York City they are even suggesting that automatic temperature control of heating systems is of insufficient value to justify its installation in postwar school buildings.

I Believe in Liberty

I believe in liberty and am constitutionally inclined to feel aggrieved when hampered by codes and rules and penalties and rations and initial-bearing bureaucrats. I can believe that civilization could prosper quite well under only the laws set forth in the Old Testament. However it does appear unreasonable when kicking out old laws that may have aroused some antagonism to abandon the engineering experience that originally evolved those laws.

Teachers are educated to transmit knowledge to the pupils and presumably do not have time to regulate radiator valves or to pull damper chains.

New York has a severe winter climate. New York uses steam heating and must install for each classroom enough heat transmitting capacity to serve on the coldest day. The coldest days are relatively few, but on these days the classrooms must be comfortable. On all other days with milder outdoor conditions, the heating capacity must be throttled so as to prevent overheating, a condition that causes even more trouble, I believe, than does underheating. The teacher then, in the absence of thermostats and valves and dampers that automatically will hold down the too-great heat, must open the windows and perform other actions for which the teacher is ill fitted. There is ample evidence that teachers simply cannot make all these adjustments. There is ample evidence also, that failure to prevent overheating brings about a great waste of fuel. The irritating rules forced upon us to save fuel oil by reducing the temperature during the last several winters probably saved some oil. There is uncontrovertible evidence that a reduction in radiator temperature following increase in outdoor temperature, possible with high vacuum steam heating and with mechanically circulated hot water, can bring about remarkable savings in fuel.

No Substitute for Control

I have designed the heating and ventilation of all the public schools in two large cities for about 35 years. I have observed health conditions and fuel consumption. I have found no substitute for thermostats to control the entering air temperature and the local heat transmission in classrooms.

Every animal has an individual and remarkably efficient automatic temperature controlling mechanism. The animal must provide heat constantly, just as does the school engineer for each classroom. If too much heat comes, the man reduces his temperature by increasing the rate of heat loss through evaporating water from his skin. The dog evaporates more water from his tongue when he is too warm. The school engineer is too busy in the basement to visit each classroom every few minutes to open and close valves or windows. The man and the dog do not have to open windows or manipulate valves. Their control mechanism attends to the matter automatically. Woe betide the man or dog if his control system ceases to function, since then a heat stroke is imminent.

Man Downstairs Doesn't Know

The children and the teacher in the classroom of course all have temperature controlling equipment, as well as the man or the dog, but they are shut up in a thickly populated, nearly airtight room and they can't ease up by moving farther away from the radiator, or if some of them get too cool there isn't anyone around to close the window, and the man downstairs doesn't know about the matter.

THE
MIGHTY
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WAR LOAN

Modern automatic temperature regulation saves in fuel, in comfort, and in health. Without its aid my own life, responsible as I am for heating and cooling systems in many different types of buildings, would be comparable to that of the kitty on the hot stove.

IN THIS regular feature, informal comment on heating, piping, and air conditioning problems is given by Samuel R. Lewis, consulting mechanical engineer, and a member of HPAC's board of consulting and contributing editors. This month he discusses automatic temperature control for school rooms, which "saves in fuel, in comfort, and in health." Mr. Lewis has been responsible for the design of the heating and ventilation of all public schools in two large cities

Practical Pointers
110
130
150
50
210

...on Operation, Maintenance, Repair, Alteration, Extension

How Much Fuel Does Building Insulation Save?

By Frank B. Rowley* and Richard C. Jordan†

The intersection chart on the following page may be used for calculating the fuel cost required to compensate for transmission heat losses. It is necessary that the heating plant efficiency, the type of fuel, the cost of fuel, the overall coefficient of heat transmission for the area involved, and the number of degree days of the heating season be known. The chart is used by starting at the heating plant efficiency, passing vertically to the intersection with the curve for the type of fuel being used, passing horizontally to the left to the fuel unit cost, passing vertically downward to the overall heat transmission coefficient, then to the right horizontally to the degree days per heating season for the locality under consideration, and then passing vertically to the cost of fuel in dollars per 1000 sq ft of area per heating season. This figure may be multiplied by any multiple or fraction of 1000 which actually represents the total square feet of area involved. If it is found that the intersection with the curve in the last quadrant is beyond the chart, any fraction of the actual number of degree days may be used and the answer thus determined multiplied by the ratio of the degree day figure used to the true degree day figure. Thus, if there are 10,000 degree days per season, and it is found that this intersection is not on the chart, the answer may be found by using the 5000 degree day line and multiplying by two.

Table 1—Central heating plant efficiencies (continuous firing)

Type of Fuel	Overall Efficiency, Per Cent
Coal (stoker fired)	65 to 75
Oil	70 to 80
Gas	75 to 85

Not only may this chart be used to calculate the cost of fuel required to compensate for transmission heat losses, but it may also be applied to determine any reduction in fuel costs resulting from the addition of insulation to a wall. After the *U* value for the uninsulated wall construction has been computed and the fuel cost determined, the chart may again be used to find the fuel cost for the second, or insulated, construction. The difference between this figure and the initial fuel cost will be the saving. An even simpler method is to multiply the initial fuel cost by the ratio of the new overall coefficient of heat transmission to the original coefficient. This will give the fuel cost for the altered construction. A third procedure is to take the difference between the overall coefficients of heat transmission for the new and the old constructions and to use this difference as the *U* value in applying the chart. The fuel cost determined in this way will be the resultant saving.

Three Ways to Use Chart

Assume, for example, a structure with 800 sq ft of outside wall area, heated by means of a heating plant with an overall efficiency of 70 per cent, and burning a No. 2 oil costing 8c per gal. The structure is located in a territory having a normal heating season of 8000 degree days. It is desired to determine the yearly fuel savings, in dollars and cents, if the overall coefficient of heat transmission for the wall is reduced from a value of $U = 0.25$

Table 2—Heating values for different types of fuels

Type of Fuel	Grade of Fuel	Heating Value
Coal	Anthracite	13,950 Btu per lb
	Semi-bituminous	13,509
	Eastern bituminous	12,417
	Western bituminous	10,064
	Sub-bituminous	9,734
	Lignite	7,002
Oil	No. 1	137,500 Btu per gal
	No. 2	139,700
	No. 3	142,200
	No. 4	144,500
	No. 5	146,000
	No. 6.	150,000
Gas	Manufactured carbureted water gas	543 Btu per cu ft
	Manufactured coke oven gas	556
	Minneapolis, Minn., (natural and manufactured gas mixed)	807
	Natural gas	900 to 1,300

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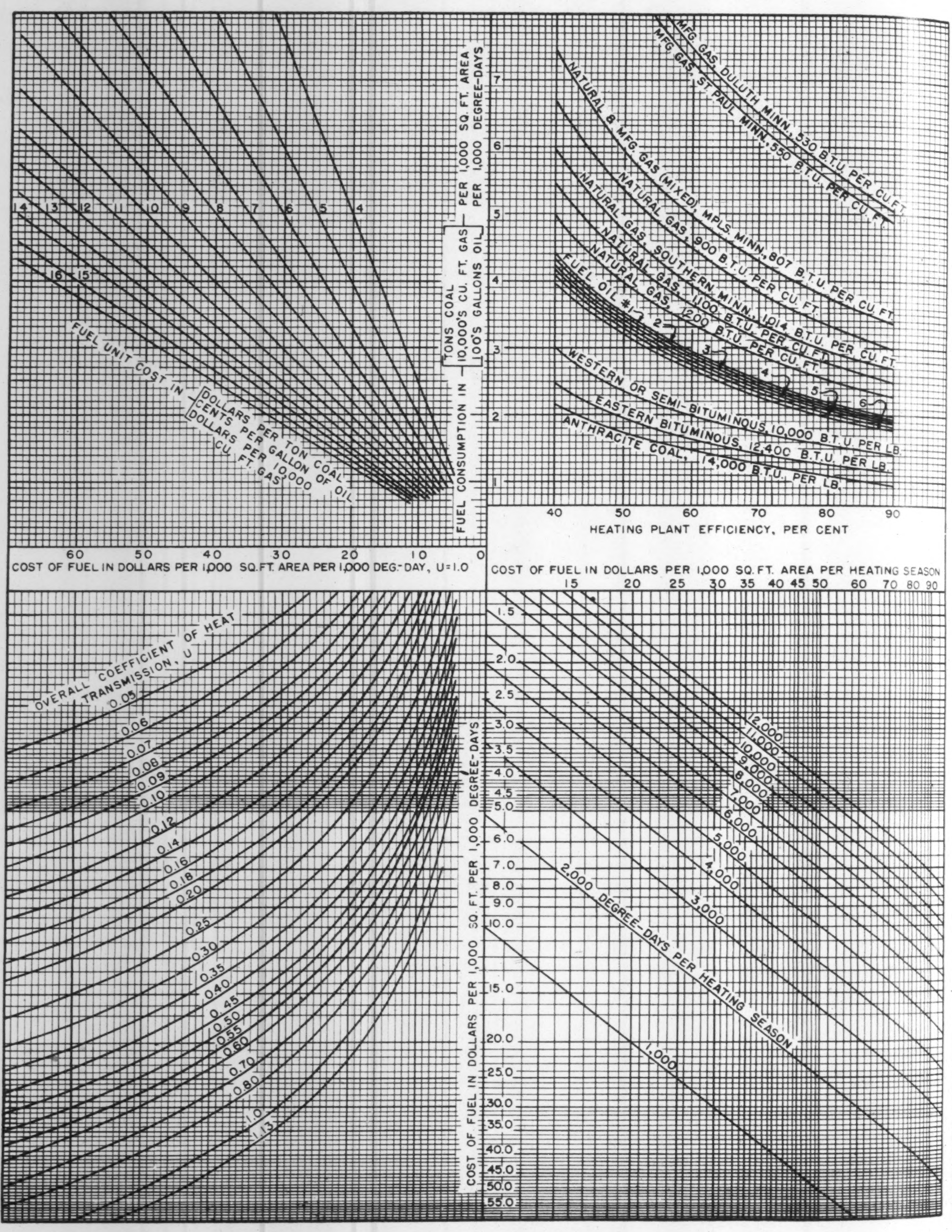
*Head of Department of Mechanical Engineering, Director of Engineering Experiment Station, University of Minnesota.

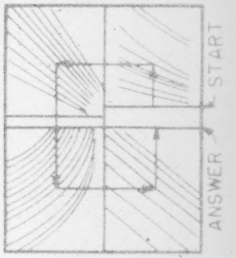
†Director of Industrial Laboratories, Department of Mechanical Engineering, University of Minnesota.



Intersection chart for determining heating fuel cost resulting from transmission heat losses through building surfaces

(See explanation of use on opposite page)

WHAT IS THE dollars-and-cents saving in fuel cost by insulating a wall, roof, or other building area? This intersection chart gives the answer for varying heating plant efficiencies, types of fuels, fuel costs, overall coefficients of heat transmission, and number of degree days per heating season. As shown by this small diagram, the large chart is entered at the heating plant efficiency, then up to the fuel curve, then to the left to the fuel unit cost, then down to the overall coefficient of heat transmission, to the right to the degree days per heating system, and up to the cost of fuel in dollars per 1000 sq ft of area per heating season. The ways of using the chart are explained in detail in the text, and tables of efficiencies and heating values for fuels are given.



to one of $U = 0.08$, by means of insulation. If these data are applied to the intersection chart, it is found that the yearly cost of fuel per 1000 sq ft of area is \$40.50 for the uninsulated wall and \$13 for the insulated wall. The fuel saving per 1000 sq ft of area is, therefore, \$27.50. For 800 sq ft of area, it is 80 per cent of this or \$22.

Using the second method, the fuel cost of the insulated wall can be calculated by multiplying the fuel cost per 1000 sq ft of uninsulated wall by the ratio of the overall coefficients of heat transmission. Thus, $(0.08/0.25) \times \$40.50 = \$13$. The difference is again \$27.50 per 1000 sq ft of area, or \$22 per 800 sq ft of area.

The yearly fuel saving may be determined by the third method by subtracting the two overall coefficients and using this difference directly. Thus, $0.25 - 0.08 = 0.17$, and again, the yearly saving in fuel per 1000 sq ft of area as determined by the intersection chart is \$27.50.

Efficiencies and Heat Contents

For convenience, two tables are presented to aid in the solution of problems. The first one shows the approximate range of heating plant efficiencies encountered in comparatively large, continuously fired, heating installations, and the second table presents heating values for different types of coal, oil, and gas fuels.

Central Refrigeration for Air Conditioning

THE EDITOR—The comments of A. C. Buensod and R. W. Waterfill in HPAC's "Open For Discussion" columns in April, on the subject of central refrigeration for air conditioning, set forth the advantages of the large centrifugal units mainly on the assumption that final heat disposal by cooling towers or evaporative condensers would be too difficult for a large number of decentralized compression units in congested areas of large cities.

Their comments also include a statement that I apparently intended to convey the impression that the auxiliary horsepower of the central plant was definitely 35 per cent greater than the decentralized plant by adding in the steam boiler plant auxiliaries in the comparison I made between two large aircraft plant air conditioning installations. A glance at the original tabulations as published in the January 1944 HPAC issue will show that each class of auxiliaries is listed in detail. The steam boiler plant auxiliaries add up to 13.4 per cent and the total water pumping and cooling tower fan power was 31.8 per cent.

I am of the opinion that the 31.8 percentage would probably be increased for a district cooling centrifugal refrigeration plant where circulating mains would be run under city streets and connected to extensive water piping lines to and through the customers' buildings.

If it becomes necessary to go to high pressure steam boiler plants with condensing turbines to secure the most favorable refrigeration production, then it would appear that a water front location for the district cooling plant would be an absolute necessity. Then how many cities would have such a location available close to the refrigeration load? Extra pumping load and water main cooling loss then make the power requirements for producing refrigeration at the points of use still greater than those tabulated for the 4000 ft long aircraft plant for which the figures were given in the January 1944 issue.

I agree that it is "bad research to draw general conclusions from isolated special cases," but I also feel that the statement that the Long Beach plant was "extensively complicated" (as stated by W. A. Grant, quoted on page 24 of the January 1944 HPAC) due to duplication of units, was somewhat of an offhand statement.—O. W. OTT, consulting mechanical engineer.

TESTING OF STEAM TRAPS

THE EDITOR—Referring to the article on trap testing, by L. W. Mauger, in the April HPAC, in our judgment, float traps used to drip risers must invariably be equipped with automatic air vent, as otherwise there is danger of the traps themselves becoming airbound.—G. A. BINZ, Sarco Co., Inc.

THE ADVENTURES OF A POUND OF STEAM 3

By A. C. Kirkwood
Burns & McDonnell Engineering Co.
Consulting Engineers

THE LAST time A.P. Steam broke into print he was reported as having been prevented from running wild down Main Street. He was confined to pipes that guided his path; his goings and comings were controlled by valves. He soon found out that friction reduced his available energy. Since these losses by friction can slow him down to a walk, it is desirable that we appreciate the nature and extent of losses of this type.

What is friction? As far as friction of fluid flow in pipes is concerned, there are two types. There is resistance caused by the rubbing of fluid on the pipe wall or on a layer of more or less static fluid adhering to that pipe wall; and there is the internal friction of the fluid caused by the fact that the flowing fluid does not have the same velocity at all points of its cross-section, thus giving rise to the rubbing of fluid particles, one on the other.

Harking back to yesteryear, we recall that the form of energy may be changed but the total energy of a given system remains constant and must all be accounted for. If steam loses energy to friction, then its form or location within the system must be ascertained. Thus, the energy of steam lost by friction on the pipes appears as heat in the pipe walls. This energy may be reabsorbed, as it is generally assumed to be in short tubes, orifices, or nozzles where high velocity flows are occurring. Highly efficient heat insulation may aid in recovery. Flow of this type (constant energy) is adiabatic. Constant temperature flow (isothermal) is assumed for most flow calculations. One should not confuse loss of heat of steam by radiation with maintenance of isothermal conditions of flow. The latter is another problem in itself.

"A.P.'s" Friction Losses

"A.P.'s" losses to friction are directly related to the speed with which he moves. Experiments have shown that at leisurely or moderate velocities all particles tend to flow in straight lines in a pipe. This occurs even though those particles next to the pipe wall are moving more slowly. As the velocity increases, this linear flow tends to be lost and turbulence sets in. This point of transition marks the "critical" velocity. Flows below the critical velocity are said to be "viscous," those above "turbulent." It should be noted that there is a layer next to the pipe wall that is always in viscous flow.

Mathematical definition of the type of flow is obtained by solution of a formula proposed by Reynolds. It results in a dimensionless number obtained from four variables: D = pipe diameter, feet; v = mean velocity, feet per second; ρ (rho) = density of fluid, pounds per cubic foot; and μ_e (mu) = absolute viscosity, pounds per foot second. The Reynolds number (Re) is: $Re = DV\rho/\mu_e$.

A SUBSCRIBER suggested to the editor recently that a series of articles on what happens to a pound of steam as it travels through an industrial piping system would be of interest to him and—he thought—to many others. Mr. Kirkwood, a member of HPAC's board of consulting and contributing editors, agreed to write about some (at least) of the adventures of A.P. Steam, and in the January issue he established the character of our hero by reference to a set of steam tables. In March he discussed some of the restraints put upon "A.P.'s" natural exuberance by valves of various types, each of which exacts some penalty in friction loss. This month, the piping friction loss encountered by "A.P." is briefly explained.

In general, viscous flow lies below $Re = 1200$, turbulent flow above $Re = 2200$. Between these values lies the critical velocity. It lacks specific value unless calculated for a particular system, since pipe roughness and the nature of entrance into the pipe both play a part in exact determinations. Many designers believe it wise to consider all values above 1200 as indicative of turbulent flow.

Since flow is accompanied by friction, it is essential to have an expression of the friction loss. The classic formula is Fanning's: $\triangle p = fL\rho v^2/2gD$, or $h_L = fLv^2/2gD$—where $\triangle p$ = pressure drop, pounds per square foot; h_L = loss of static head, feet of fluid; f = a friction factor; L = length of pipe, feet; g = acceleration of gravity, 32.2 feet per second per second; and the other nomenclature is as before.

This formula holds for both viscous and turbulent flows of any fluids and may be used, with restrictions, for gases and vapors. With steam it is desirable to limit application to conditions where pressure loss is less than 10 per cent of the lower or final pressure. If greater than 10 per cent loss is expected, study the pipe in short sections.

The friction factor (f) must be determined prior to solution of any problem. For viscous flows it is independent of the roughness of the pipe wall and $f = 64/Re$. Should this value be substituted in Fanning's equation, the pressure drop in pounds per square foot is $\triangle p = 64\mu_e Lv/2gD^2$. This is Poiseuille's law for viscous flow.

Where flow is turbulent the roughness of the pipe wall is of greater influence and the solution for factor f is an intricate operation unless tables and charts are used. R. J. S. Pigott and Emory

Kemler in 1933 presented through the ASME some quite complete and commonly accepted data in chart and table form. These have been reprinted —with much other data —in a booklet on the Flow of Fluids.*

"A.P.'s" Viscosity

More than mere reference should be made to the viscosity of the fluid. The term denotes the reaction in flow of a fluid to which an external shearing force is applied. In other words, it is the fluid's resistance to shear.

The usual practice is to state the absolute viscosity in the centimeter-gram-second (CGS) system unit called the "centipoise." The kinematic viscosity of a fluid is obtained by dividing the absolute viscosity by the density. The CGS unit for kinematic viscosity is the "centistoke."

The calculation of pressure drop in a piece of pipe has apparently become involved. What with the Reynolds numbers, Fanning's formula, kinematic viscosity, and what not, it sounds formidable. But A.P. Steam has still another little trait of character. He insists on a statement of his physical condition in terms of absolute pressure; refer him to a perfect vacuum or his characteristics are unintelligible.

Actually, the calculation of friction losses is a tedious task. Its very tediousness has given impetus to that ancient and honorable American custom of shortcuts. But before considering shortcuts it is well to understand the application of basic principles involved in the "long way."

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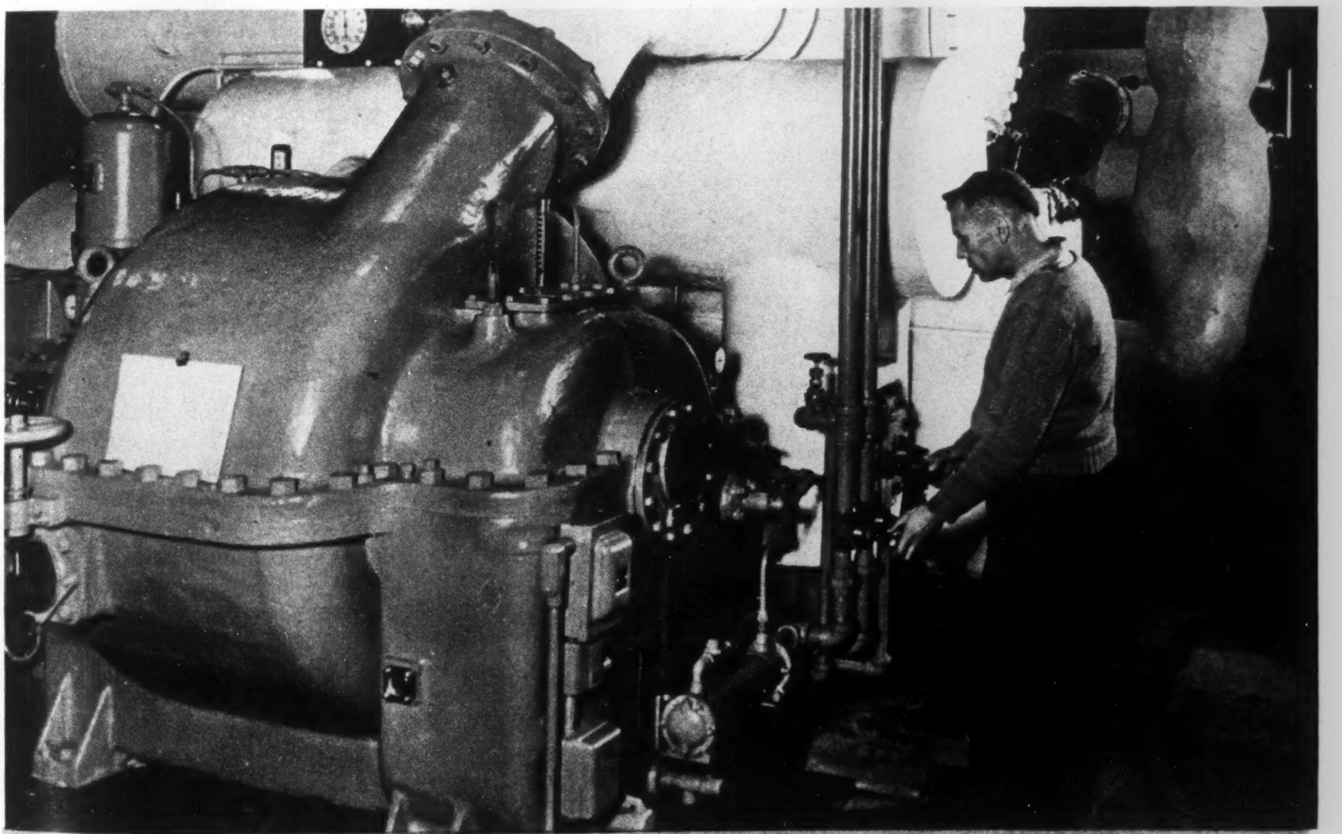
*Technical Paper No. 409, Crane Co., Chicago, May 1942.

Air Conditioning Speeds Output in Bearing Industry

To protect high precision accuracy in vital bearing plants, SKF Industries uses air conditioning equipment with a capacity of 2000 tons of refrigeration which performs four essential jobs, all aimed at improved production and a reduction of spoiled parts. They are: (1) Helping to prevent stain-producing humidity from attacking finely finished bearing parts, or assembled bearings during handling, in assembly and final inspection. (2) Helping to maintain accurate dimensional controls not affected by varying outdoor climate conditions. (3) Keeping factory atmosphere free from lint and dust, dirt, vapor, and grinding grit which normally collect on the oiled surface of bearing races, balls, and rollers. (4) Preventing excessive summer temperature from increasing fatigue and lowering efficiency.



This is one of four "Freon 12" compressors which supply 4000 gpm of chilled water for air conditioning an SKF blackout plant. (Courtesy the York Corp.)

Saving Fuel—and Dollars—in LAUNDRY OPERATION

By Harold M. Toombs, Chief Engineer, Stevens Hotel

COST OF the power plant operation represents from 7 to 10 per cent of the total operating expense of a laundry. This is an important item. Any reduction that is made here goes directly as a surplus onto the right side of the ledger. In the past this has been a very important consideration in the management of a laundry business, but in wartime it becomes a patriotic duty to ferret out preventable fuel losses.

Let us examine the record and discover just how steam is utilized. The analysis is made in the form of a steam balance in similar form to that used in testing boilers.

The laundry that we are about to analyze has been described in the press as follows: "15,000 towels are ironed on a single machine in one day, while two large flatwork ironers turn out 6000 sheets in 24 hr and 80,000 pieces of linen may be washed in the same length of time."

Now this same laundry, when described by the lowly engineer, reads as follows: Pounds processed per month, 600,000; pounds of steam consumed, 1,500,000; gallons of water used, 2,700,000. This boils down to about 2.5 lb of steam per lb of finished laundry and 4.5 gal of water, both hot and cold. To get out this volume, you knock out an average of 2500 lb per hr of finished work. The steam required would weigh 6250 lb and the water 92,500 lb.

It requires a certain amount of piping to convey this steam to the laundry machines and nearly the equivalent in running feet to return the condensate back to the boiler room. A given amount of heating surface is required for evaporating the water from the articles that are either rough dried or ironed. So the engineer takes a check on the square feet of radiating or heating surface required to accomplish this work, and for the personal items such as shirts, collars, socks, etc., finds an installed capacity of 490 sq ft. This includes both sides of both the upper and lower buck. The rough dryers have 750 sq ft in ¾ in. pipe and the ironers 760 sq ft. There is 2500 sq ft of feed and return piping.

Using a value of 2 to 2½ Btu per hr per sq ft of surface per degree temperature difference, it is estimated that the radiation loss is equivalent to some 2000 lb per hr of steam. When that cast iron and steel is heated and just stands there, doing no work, that is the constant and continuous loss.

The next step is to rough dry or iron the work. This is more scientifically defined as evaporating out the moisture. Let's assume that the extractors are not so hot and that with 2500 lb of finished weight it was necessary that 1000 lb of water be evaporated. To evaporate 1 lb of moisture requires about 1000 Btu, and since there is 1000 Btu in 1 lb of steam, it would require 1000 lb of steam.

When the articles go through the flatwork ironer or are rough dried, the sensible heat temperature of sheets, panties, or what not is raised from room temperature to 180 deg. I could not find the specific heat of towels or shirts but it is not great; so there is, say, another 250 lb per hr of steam consumed.

ANY PLANT using steam and hot water for processing can apply the heat balance method and the heat saving suggestions given here by Mr. Toombs. Conservation of fuel is always good business and in wartime it becomes a patriotic duty as well. This article is taken from a talk given by the author before a group of laundry managers.

The heat needed to raise the temperature of the water for washing is arrived at by assuming that 40 per cent of the required water is raised to a temperature of 180 deg. The heat to accomplish this comes from the return condensate and possibly leaky traps bypassing steam to the heater or directly by live steam. It makes no difference what method is used, the heat requirements are the same. We are not talking about economy now, but total heat requirements. We find this amounts to some 3700 lb per hr of steam.

I do not care what kind of heat recovery apparatus is used, that is the number of heat units required to do that particular job.

The washing having been ironed, let us summarize:

	Lb/Hr Steam	% of Total
1. Radiation	2000	29
2. Evaporation of Moisture.	1000	14
3. Rise in sensible heat....	250	4
4. Heating water	3700	53

Now that we know where we are going, let us see what can be doped out from these figures.

Nothing can be done towards conservation of fuel for evaporation of water. The amount of evaporation is fixed. It makes no difference how fast the work may travel through the ironer, it takes just so many Btu's to evaporate the moisture in there.

The same thing applies to rise in sensible heat. It cannot be changed.

The total Btu required to heat the water cannot be changed, but any exhaust to the atmosphere, trap discharge, reclamation of heat from waste hot water, through the medium of a heat exchanger, will show a gain. With sufficient surface in an exchanger the effluent can be dropped in temperature to within 5 deg of the incoming cold water. However, heat exchangers are made from critical materials, so we will not toy long with that idea.

The antonym for radiation is insulation, the thing that keeps the plant cool in summer and warm in winter. Twenty-nine per cent of the total heat in all the steam that is delivered and it's all loss is lost to the atmosphere. The exhaust fan used in this laundry to take the heat and vapor from the ironers is powered with a 35 hp motor which is just 25 per cent of the installed motor capacity that operates the entire plant. That gives you an idea of how much radiation there is. With good insulation the radiation from bare steel surface can be reduced from five to 12 times.

Steam lines, condensate lines, fittings, traps—all should receive their share of attention. Ragged, loose and thin covering should be renewed. Valves, unions and everything that you do not like to cover—all emit heat, a dead loss. The undersides of bucks are not generally insulated, nor flatwork ironers. Maybe this cannot be done in a practical way; however, the waste in heat is there. At least it is worth a study for they all radiate heat which is not gainfully used. The easiest, quickest, and best way to save heat or radiation losses is to shut off the steam valves when the presses and ironers are not in operation. It should be the supervisor's job to do this.

Let me quote some daily figures, from the record, on pounds of steam consumed per pound of dry weight: Sept. 18, 2.45. Sept. 19, 3.45. Sept. 20, 3.42. Sept. 21, 3.22. Sept. 22, 4.29—steam not shut off till 1 a. m. Caught by night man. Loss 20,000 lb. Sept. 23, 3.52. Sept. 24, 5.16 (Sunday). Sept. 25, 3.01. Sept. 26, 4.43—steam left on all night. Loss 20,000 lb.

Use the steam when needed. Shut off the valves when through. That is why they are, or should be, on the machine. If fittings are made up right and stuffing boxes are tight, presses will not leak. I am not recommending a dead shutdown on the coldest night of winter. A certain amount of sensible moderation must be used in all things.

When steam is generated, it must be used. I have said this before and I say it again. The only place that heat can be stored is in water; otherwise, the Btu's just flit away from you.

It should not be necessary to caution about steam leaks. They are self-evident and, if countenanced, reflect badly on operation.

Air vents are often used to advantage. Trapped air in the steam chests or lines will slow up all drying operations. The same thing is true of foreign gases in the steam which can originate with certain types of boiler water treatments. If suitable openings are found, install some vents.

Cold drafts on any of the heating equipment materially increase the rate of condensation of the steam. Ironers and presses should be protected.

Turn out the electric lights promptly, when not in use. In our plant there is a 10 min rest period in the morning and again in the afternoon. With all the lights burning during this period it represents a loss of 35 lb of coal somewhere, somehow, along the line. Leaky blowoff valves on hot water heaters also waste a great amount of steam.

Do not run motors needlessly. It all reverts to the coal pile. Centrifugal pumps that only churn the water, leaky pump valves, ill fitting piston rings, bad rods, poor packing—all are sources of coal waste. Use care and study in the banking of the boilers. Here coal just melts away.

Compressed air is expensive. Get the moisture out of it before going to the presses. Then the packings will not have such a tendency to leak.

Ventilating fans used in summer may not be required in winter. Shut them down if possible. Employ natural ventilation where possible. It will help save fuel. If skylights can be added to eliminate artificial light, it is a means to the end. The economical use of all raw supplies helps out, also. Fuel has been consumed by some manufacturers in their preparation for you.

Careful, intelligent planning will work wonders toward the saving of fuel which, once burned, is gone.

Careful, intelligent planning in laundry operation will work wonders toward the saving of fuel which, once burned, is gone

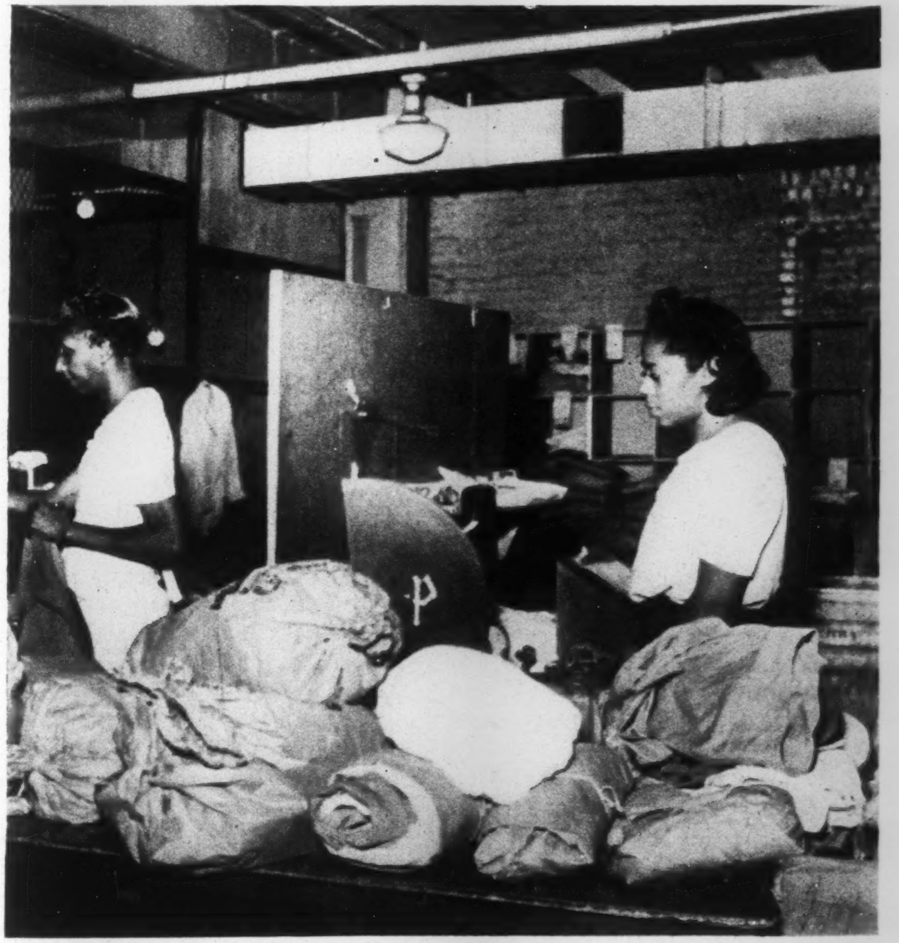


Fig. 1—John Kasper, of the Hanna Engineering Works, shows the reader and the author (seated) how to start a sketch.

DRAWING AND IMAGINATION

V. L. Sherman Stresses Advantages of Isometrics for Piping Layouts

"Beautiful Soup! Who cares for fish,
Game, or any other dish?
Who would not give all else for two p
Ennyworth only of beautiful soup?"
—song of The Mock Turtle

THAT WAS written by a famous mathematician. He had that quality . . . so desirable . . . imagination. We can call it space perception, visualization, or any other name we choose, but it means freedom from restraint.

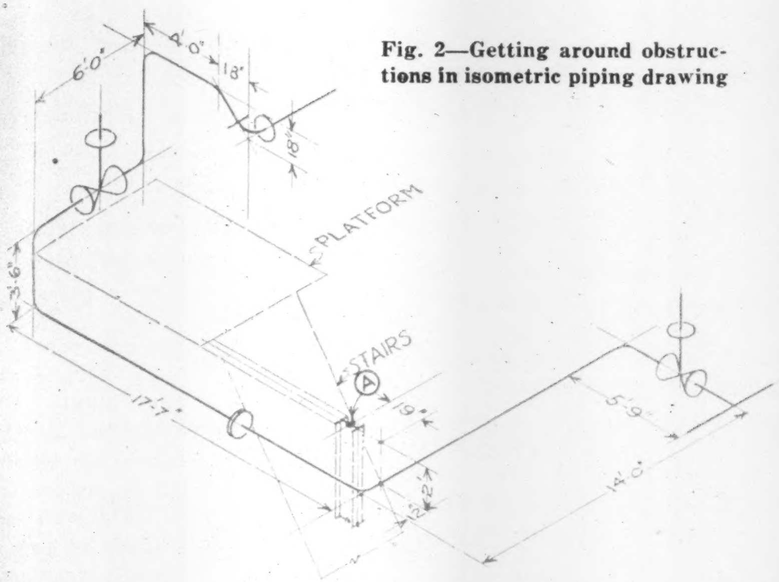
In my last article, in the March HPAC, the discussion pointed to drawing as a means to an end, not as an end product. Drawing is said to be the universal language of engineers. It *should* be, but is it? I had occasion the other day to examine a patent. As the "description" progressed the various figures in the patent drawings were studied —and "studied" is expressing it mildly. There were about six sheets of a comparatively simple piece—plans, elevations, cross-sections, all in orthographic projection and on separate sheets. Some were called "diagrammatic." That was merely an apology, for it was very difficult to identify the parts in the several views.

Balancing the disappointment of the patent examination was a visit to an engineering works. They have use for perspectives. In Fig. 1, one of the designers is explaining the sketching of a squeeze riveter. The figure to which he is pointing is drawn merely for the purposes of discussion.

Starting Point Is Center of Circle

The center of any circle is used as a starting point. In this case it was the center of a 14 in. arc at the top of the riveter frame. The center line *1* gave the start. Long diameter *2* and ellipse *3* determined the position of the frame, the plumb line *4* and the tangent *5* following the position of the base ellipse. Other lines, sketched in numerical order, are used when and if

Fig. 2—Getting around obstructions in isometric piping drawing



required. Determining the amount of foreshortening in any of the three axial directions is by reference to the lines *A*, *B*, and *C*. Some of this construction can be seen, sketched in lightly on the riveter frame. It was pointed out that center lines, circles, and arcs are very important and are the foundation of all good perspective sketching. The work must be accurate, just as in orthographic drawing.

The placing of arrow points and dimension numerals was stressed. The arrow points and the numerals are best shown as if placed in the same plane as the dimensional plane. This is shown in the vertical dimensioning at the left of the frame. However, in the case of the 36 in. dimension below an exception is taken. Chalk, yardstick, and eraser were the tools used.

Then the pendulum swung back. The writer looked over the "plan and sections" of a piping arrangement. The plan was over to the left of the sheet. The front view ranged alongside to the right with the right side view directly above it. The general arrangement of the piping served to avoid a platform and stairs and some columns.

A Piping Isometric

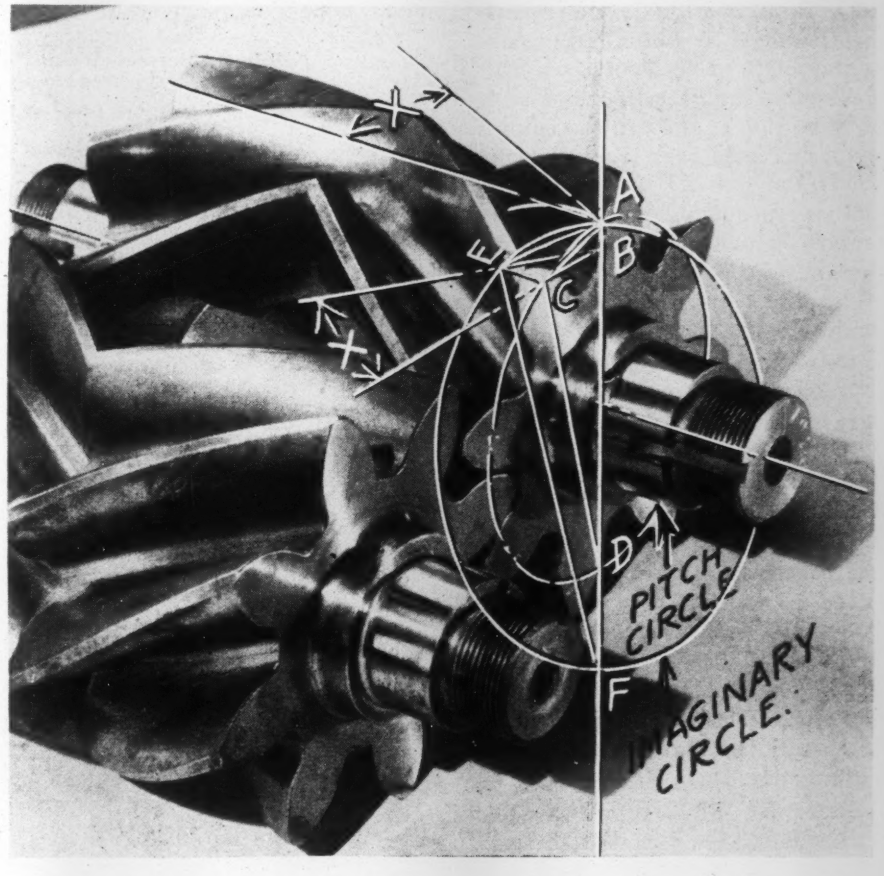
Fig. 2 is just a suggestion that an isometric, starting from the center of the column, at *A*, on a level with the platform, might help to set things right at the start. The sketch, of course, is not complete by any means, and far too small to be of any real use for notations. Isometric drawings can be made in less space than orthographic drawings, and if made to a suitable scale can be more easily dimensioned and noted. It is the writer's opinion that in almost all cases of pipe layouts, the less pictorial work appearing on the drawing the better. Centers, center lines, dimensions and notes are most important. Capable workmen do not need pictures of parts where piping is concerned. Identification of fittings by notation is far better than a picture of the fitting. Conventional drawings in isometric are best in pipe layouts.

Good Photographs Save Time

Good photographs save a lot of time. They are a great aid to visualization, particularly if one is too lazy to make a drawing. In this case it was desired to show the imaginary pitch circle on which to determine the tooth shape in a pair of helically cut gears. Fortunately, the photograph of the herringbone gears shown in Fig. 3 was forthcoming. In ordinary spur gears the number of teeth in the gear determines the form of the tooth curve. In bevel gearing the form of the tooth is determined by the number of teeth in an imaginary gear having a pitch radius of the "back cone."

But in a helical gear the imaginary pitch circle, from which the tooth form is determined, is one which has the radius of a helix

Fig. 3—The imagery of virtual pitch circle determining the tooth shape of a helical gear. (Photograph courtesy of D. O. James Mfg. Co.)



which is drawn perpendicularly to the cutting helix. Same idea as before, an imaginary gear placed at right angles to the tooth cuts. Now a helix has a radius, albeit an instant radius with an instant center.

This radius can be determined by means of the perspective circles shown in Fig. 3. A right angle triangle, *ACD*, is drawn within the pitch circle of the herringbone gear. A perpendicular is drawn from *B* to *C*. From *B* a line is drawn making the angle *X*, which is the same as the angle of the tooth cut. This makes the line *BC* perpendicular to the direction of the cut, the point *E* being projected back from the point *C*. If the line *AE* is then drawn and a perpendicular is drawn down from this line, the point *F* is located. *AF* is the diameter of a circle lying in a plane at right angles to the tooth cut.

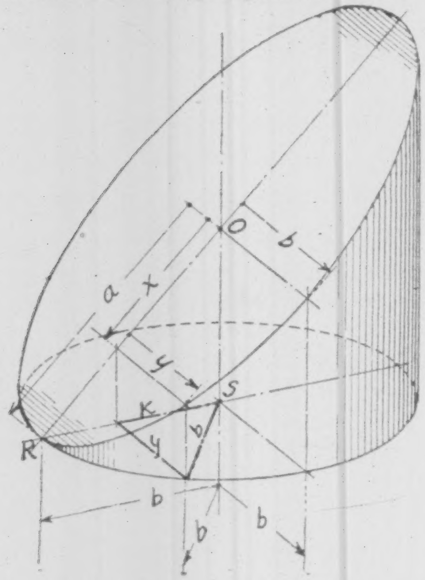


Fig. 4—The ellipse considered as a cylindrical section

By construction, then, $AB/BC = BC/BD$, or $AB = (BC)^2/BD$, and $AB/BE = BE/BF$, or $AB = (BE)^2/BF$. Then $(BC)^2/BD = (BE)^2/BF$, or $BF = [(BE)^2/(BC)^2] \times BD$.

Of course the point *E* is not on the perpendicular helix, so the distance *AB* is made to approach zero. No matter how short the distance becomes, the same equations hold good. The distance *BD* approaches the pitch diameter *AB*, and the distance *BF* the diameter of the imaginary circle.

Since $BE/BC = \text{secant } X$, then $(BE)^2/(BC)^2 = \text{secant}^2\ X$, and the instant diameter of the perpendicular helix is the diameter of the pitch circle multiplied by the square of the secant of the cutting angle.

Since the number of teeth in a spur gear of the same diameter as the herringbone equals the number of teeth in the herringbone times the secant of the cutting angle, then the number of teeth in the imaginary gear, from which the tooth form is determined, is equal to the number of teeth in the herringbone times the cube of the secant of the cutting angle.

Words, language, and imagination have early beginnings, as was shown by the little first-grader who told his mother that the equator was "a menagerie lion running about the world." According to the writer's experience, training in perspective sketching should precede any study of orthographic. Some amazing results might thus be avoided.

Fig. 4 is intended to do away with the exponents of the ellipse equation thus:

In considering the triangle *ORS*, $(x/a) = (k/b)$, and $k = \sqrt{b^2 - y^2}$, then

$(x/a) = (\sqrt{b^2 - y^2}/b)$ which, if one insists, may be read $b^2x^2 + a^2y^2 = a^2b^2$ or $(x^2/a^2) + (y^2/b^2) = 1$.

The same equations can be derived from the construction which is used to locate points on an ellipse. But a perspective sketch, or a model, which shows the ellipse as it develops from a section of a solid, and compares lengths rather than suggesting areas by squaring the lengths, is more satisfactory.

The author's apologies for this mathematical harangue. His excuse is that Lewis Carroll, whose verse heads this article, is still his favorite mathematician.

Comparative Data on Refrigerants

IN DECIDING which refrigerant to use under a specific set of conditions, tables are needed which give engineering data such as weight and volume of refrigerant to be circulated per ton, and horsepower and capacity. Such tables, in addition to the basic tables of thermodynamic properties, are of value in showing at a glance just which

Methyl chloride—Weight of refrigerant to be circulated
(Saturated vapor leaving evaporator)
Lb per min per ton of refrigerating capacity

Evap Temp	Temperature of liquid ahead of expansion valve													
	60	65	70	75	80	85	90	95	100	105	110	115	120	125
-20	1.28	1.29	1.31	1.32	1.34	1.36	1.38	1.40	1.41	1.44	1.46	1.48	1.50	1.52
-18	1.27	1.29	1.30	1.32	1.34	1.36	1.37	1.39	1.41	1.43	1.45	1.47	1.50	1.52
-16	1.27	1.29	1.30	1.32	1.34	1.35	1.37	1.39	1.41	1.43	1.45	1.47	1.49	1.51
-14	1.27	1.28	1.30	1.32	1.33	1.35	1.37	1.39	1.41	1.43	1.45	1.47	1.49	1.51
-12	1.27	1.28	1.30	1.31	1.33	1.35	1.37	1.38	1.40	1.42	1.44	1.46	1.48	1.51
-10	1.26	1.28	1.30	1.31	1.33	1.35	1.36	1.38	1.40	1.42	1.44	1.46	1.48	1.50
- 8	1.26	1.28	1.29	1.31	1.33	1.34	1.36	1.38	1.40	1.42	1.44	1.46	1.48	1.50
- 6	1.26	1.28	1.29	1.31	1.32	1.34	1.36	1.38	1.40	1.41	1.44	1.46	1.48	1.50
- 4	1.26	1.27	1.29	1.30	1.32	1.34	1.36	1.38	1.39	1.41	1.43	1.45	1.47	1.50
- 2	1.26	1.27	1.29	1.30	1.32	1.34	1.35	1.37	1.39	1.41	1.43	1.45	1.47	1.49
0	1.25	1.27	1.28	1.30	1.32	1.33	1.35	1.37	1.39	1.41	1.43	1.45	1.47	1.49
2	1.25	1.27	1.28	1.30	1.31	1.33	1.35	1.37	1.38	1.40	1.42	1.44	1.46	1.49
4	1.25	1.26	1.28	1.30	1.31	1.33	1.35	1.36	1.38	1.40	1.42	1.44	1.46	1.48
6	1.25	1.26	1.28	1.29	1.31	1.33	1.34	1.36	1.38	1.40	1.42	1.44	1.46	1.48
8	1.24	1.26	1.28	1.29	1.31	1.32	1.34	1.36	1.38	1.40	1.42	1.44	1.46	1.48
10	1.24	1.26	1.27	1.29	1.30	1.32	1.34	1.36	1.38	1.39	1.41	1.43	1.45	1.47
12	1.24	1.26	1.27	1.29	1.30	1.32	1.34	1.35	1.37	1.39	1.41	1.43	1.45	1.47
14	1.24	1.25	1.27	1.28	1.30	1.32	1.33	1.35	1.37	1.39	1.41	1.43	1.45	1.47
16	1.24	1.25	1.27	1.28	1.30	1.32	1.33	1.35	1.37	1.39	1.40	1.42	1.44	1.47
18	1.24	1.25	1.26	1.28	1.30	1.31	1.33	1.35	1.36	1.38	1.40	1.42	1.44	1.46
20	1.23	1.25	1.26	1.28	1.29	1.31	1.33	1.34	1.36	1.38	1.40	1.42	1.44	1.46
22	1.23	1.25	1.26	1.28	1.29	1.31	1.32	1.34	1.36	1.38	1.40	1.42	1.44	1.46
24	1.23	1.24	1.26	1.28	1.29	1.31	1.32	1.34	1.36	1.38	1.40	1.41	1.44	1.46
26	1.23	1.24	1.26	1.27	1.29	1.30	1.32	1.34	1.36	1.38	1.39	1.41	1.43	1.45
28	1.23	1.24	1.26	1.27	1.29	1.30	1.32	1.34	1.35	1.37	1.39	1.41	1.43	1.45
30	1.22	1.24	1.25	1.27	1.28	1.30	1.32	1.33	1.35	1.37	1.39	1.41	1.43	1.45
32	1.22	1.24	1.25	1.27	1.28	1.30	1.32	1.33	1.35	1.37	1.39	1.40	1.43	1.44
34	1.22	1.24	1.25	1.27	1.28	1.30	1.31	1.33	1.35	1.37	1.38	1.40	1.42	1.44
36	1.22	1.23	1.25	1.26	1.28	1.30	1.31	1.33	1.35	1.36	1.38	1.40	1.42	1.44
38	1.22	1.23	1.25	1.26	1.28	1.29	1.31	1.33	1.34	1.36	1.38	1.40	1.42	1.44
40	1.22	1.23	1.24	1.26	1.28	1.29	1.31	1.32	1.34	1.36	1.38	1.40	1.42	1.44
42	1.21	1.23	1.24	1.26	1.27	1.29	1.30	1.32	1.34	1.36	1.38	1.40	1.41	1.43
44	1.21	1.23	1.24	1.26	1.27	1.29	1.30	1.32	1.34	1.36	1.37	1.39	1.41	1.43
46	1.21	1.23	1.24	1.26	1.27	1.28	1.30	1.32	1.34	1.35	1.37	1.39	1.41	1.43
48	1.21	1.22	1.24	1.25	1.27	1.28	1.30	1.32	1.33	1.35	1.37	1.39	1.41	1.43
50	1.21	1.22	1.24	1.25	1.27	1.28	1.30	1.32	1.33	1.35	1.37	1.39	1.40	1.42
52	1.21	1.22	1.24	1.25	1.26	1.28	1.30	1.31	1.33	1.35	1.36	1.38	1.40	1.42
54	1.20	1.22	1.23	1.25	1.26	1.28	1.29	1.31	1.33	1.34	1.36	1.38	1.40	1.42
56	1.20	1.22	1.23	1.25	1.26	1.28	1.29	1.31	1.33	1.34	1.36	1.38	1.40	1.42
58	1.20	1.22	1.23	1.24	1.26	1.28	1.29	1.31	1.32	1.34	1.36	1.38	1.40	1.42

Methyl chloride—Theoretical capacity of refrigerating compressors
(Saturated vapor leaving evaporator)
Tons per cu ft per min of vapor compressed

Temperature of liquid ahead of expansion valve

Evap Temp	60	65	70	75	80	85	90	95	100	105	110	115	120	125
-20	0.101	0.0998	0.0986	0.0973	0.0961	0.0948	0.0936	0.0923	0.0912	0.0898	0.0886	0.0873	0.0861	0.0847
-18	.106	.105	.103	.102	.101	.0995	.0982	.0969	.0957	.0943	.0930	.0917	.0903	.0890
-16	.111	.110	.108	.107	.106	.104	.103	.102	.100	.0989	.0976	.0962	.0948	.0934
-14	.117	.115	.114	.112	.111	.110	.108	.107	.105	.104	.102	.101	.0994	.0979
-12	.122	.121	.119	.118	.116	.115	.113	.112	.110	.109	.107	.106	.104	.103
-10	0.128	0.126	0.125	0.123	0.122	0.120	0.119	0.117	0.116	0.114	0.112	0.111	0.109	0.108
- 8	.134	.132	.131	.129	.128	.126	.124	.123	.121	.119	.118	.116	.114	.113
- 6	.140	.139	.137	.135	.134	.132	.130	.129	.127	.125	.123	.122	.120	.118
- 4	.147	.145	.143	.142	.140	.138	.136	.134	.133	.131	.129	.127	.125	.124
- 2	.154	.152	.150	.148	.146	.144	.143	.141	.139	.137	.135	.133	.131	.129
0	0.160	0.159	0.157	0.155	0.153	0.151	0.149	0.147	0.145	0.143	0.141	0.139	0.137	0.135
2	.168	.166	.164	.162	.160	.158	.156	.154	.152	.150	.148	.146	.143	.141
4	.175	.173	.171	.169	.167	.165	.163	.160	.158	.156	.154	.152	.150	.148
6	.183	.181	.179	.176	.174	.172	.170	.168	.166	.163	.161	.159	.157	.154
8	.191	.189	.186	.184	.182	.180	.177	.175	.173	.170	.168	.166	.163	.161
10	0.199	0.197	0.195	0.192	0.190	0.187	0.185	0.182	0.180	0.178	0.175	0.173	0.170	0.168
12	.208	.205	.203	.200	.198	.196	.193	.190	.188	.185	.183	.180	.178	.175
14	.217	.214	.212	.209	.206	.204	.201	.198	.196	.193	.191	.188	.185	.183
16	.226	.223	.220	.218	.215	.212	.210	.207	.204	.201	.199	.196	.193	.190
18	.235	.232	.230	.227	.224	.221	.218	.215	.213	.210	.207	.204	.201	.199
20	0.245	0.242	0.239	0.236	0.233	0.230	0.227	0.225	0.222	0.219	0.216	0.213	0.210	0.207
22	.255	.252	.249	.246	.243	.240	.237	.234	.231	.228	.225	.222	.218	.215
24	.265	.262	.259	.256	.253	.249	.246	.243	.240	.237	.234	.231	.227	.224
26	.276	.273	.269	.266	.263	.260	.256	.253	.250	.246	.243	.240	.236	.233
28	.287	.283	.280	.277	.273	.270	.267	.263	.260	.256	.253	.249	.246	.243
30	0.298	0.295	0.291	0.288	0.284	0.281	0.277	0.274	0.270	0.267	0.263	0.259	0.256	0.252
32	.310	.306	.303	.299	.295	.292	.288	.284	.281	.277	.273	.270	.266	.262
34	.322	.318	.314	.310	.307	.303	.299	.295	.291	.288	.284	.280	.276	.272
36	.334	.330	.326	.322	.318	.315	.311	.307	.303	.299	.295	.291	.287	.283
38	.347	.343	.339	.334	.331	.326	.322	.318	.314	.310	.306	.302	.298	.293
40	0.360	0.356	0.351	0.347	0.343	0.339	0.335	0.330	0.326	0.322	0.318	0.313	0.309	0.305
42	.373	.369	.365	.360	.356	.351	.347	.343	.338	.334	.329	.325	.321	.316
44	.387	.383	.378	.374	.369	.365	.360	.356	.351	.346	.342	.337	.333	.328
46	.401	.397	.392	.387	.383	.378	.373	.369	.364	.359	.354	.350	.345	.340
48	.416	.411	.406	.402	.397	.392	.387	.382	.378	.373	.368	.363	.358	.353
50	0.431	0.426	0.421	0.416	0.411	0.406	0.401	0.396	0.391	0.386	0.381	0.376	0.371	0.366
52	.447	.442	.436	.431	.426	.421	.416	.410	.405	.400	.395	.389	.384	.379
54	.463	.457	.452	.447	.441	.436	.431	.425	.420	.414	.409	.403	.398	.393
56	.479	.474	.468	.463	.457	.451	.446	.440	.435	.429	.424	.418	.412	.406
58	.496	.490	.484	.478	.473	.467	.461	.456	.450	.444	.438	.433	.426	.421

Methyl chloride—Theoretical horsepower of refrigerating compressors
(Saturated vapor entering compressor)
Horsepower per ton

Condensing temperature

Evap Temp	60	65	70	75	80	85	90	95	100	105	110	115	120	125
-20	1.01	1.08	1.16	1.23	1.31	1.39	1.37	1.56	1.64	1.72	1.82	1.91	2.00	2.10
-18	0.976	1.05	1.12	1.20	1.28	1.36	1.44	1.52	1.60	1.69	1.78	1.87	1.96	2.05
-16	0.942	1.01	1.09	1.16	1.24	1.32	1.40	1.48	1.56	1.65	1.73	1.82	1.91	2.00
-14	0.908	0.980	1.05	1.12	1.20	1.28	1.36	1.44	1.52	1.60	1.69	1.77	1.86	1.95
-12	0.877	0.947	1.02	1.09	1.17	1.24	1.32	1.40	1.48	1.56	1.64	1.73	1.82	1.91
-10	0.845	0.915	0.984	1.06	1.13	1.20	1.28	1.36	1.44	1.52	1.60	1.69	1.78	1.86
- 8	.814	.883	.952	1.02	1.09	1.17	1.24	1.32	1.40	1.48	1.56	1.65	1.73	1.82
- 6	.782	.851	.919	0.988	1.06	1.13	1.21	1.28	1.36	1.44	1.52	1.60	1.69	1.77
- 4	.752	.819	.887	0.955	1.03	1.10	1.17	1.25	1.32	1.40	1.48	1.56	1.65	1.73
- 2	.723	.789	.856	0.924	0.994	1.06	1.14	1.21	1.29	1.36	1.44	1.52	1.61	1.69
0	0.693	0.758	0.824	0.891	0.960	1.03	1.10	1.18	1.25	1.32	1.40	1.48	1.56	1.65
2	.664	.728	.793	.860	.928	0.998	1.07	1.14	1.21	1.29	1.37	1.44	1.52	1.61
4	.635	.699	.763	.829	.896	0.963	1.03	1.11	1.18	1.25	1.33	1.41	1.49	1.57
6	.608	.670	.734	.799	.865	0.932	1.00	1.07	1.14	1.22	1.29	1.37	1.45	1.53
8	.580	.642	.705	.769	.834	0.901	0.968	1.04	1.11	1.18	1.26	1.33	1.41	1.49
10	0.552	0.614	0.675	0.739	0.804	0.870	0.936	1.01	1.08	1.15	1.22	1.29	1.37	1.45
12	.525	.586	.647	.710	.774	.839	.905	0.974	1.04	1.11	1.18	1.26	1.33	1.41
14	.499	.560	.620	.682	.747	.811	.875	0.943	1.01	1.08	1.15	1.22	1.30	1.37
16	.476	.535	.594	.655	.719	.782	.846	0.913	0.981	1.05	1.12	1.19	1.26	1.34
18	.449	.508	.567	.626	.689	.752	.816	0.882	0.948	1.02	1.09	1.16	1.23	1.30
20	0.425	0.483	0.541	0.600	0.661	0.724	0.787	0.852	0.917	0.986	1.05	1.12	1.19	1.27
22	.400	.456	.514	.573	.633	.695	.756	.822	.887	.953	1.02	1.09	1.16	1.23
24	.376	.432	.488	.546	.606	.667	.728	.793	.857	.922	0.989	1.06	1.13	1.20
26	.352	.408	.463	.520	.580	.640	.700	.765	.827	.893	0.958	1.02	1.09	1.16
28	.329	.384	.439	.495	.554	.613	.673	.737	.799	.863	0.928	0.993	1.06	1.13
30	0.306	0.360	0.415	0.469	0.527	0.586	0.646	0.708	0.770	0.833	0.897	0.961	1.03	1.10
32	.284	.338	.392	.445	.503	.562	.621	.683	.743	.806	.869	.932	1.00	1.07
34	.261	.315	.368	.421	.477	.535	.594	.655	.715	.777	.339	.903	0.967	1.03
36	.240	.293	.346	.398	.454	.511	.569	.629	.689	.750	.812	.874	0.938	1.00
38	.217	.269	.323	.374	.429	.485	.543	.602	.660	.721	.782	.844	0.908	0.973
40	0.196	0.248	0.301	0.352	0.406	0.462	0.518	0.576	0.634	0.695	0.754	0.816	0.879	0.944
42	.175	.227	.279	.329	.383	.438	.494	.552	.609	.668	.728	.789	.850	.914
44	.155	.206	.258	.308	.360	.415	.470	.526	.583	.642	.702	.761	.822	.885
46	.134	.185	.236	.286	.338	.391	.446	.502	.558	.616	.675	.734	.794	.857
48	.114	.165	.215	.265	.316	.368	.422	.478	.533	.591	.648	.707	.767	.828
50	0.0937	0.144	0.194	0.243	0.294	0.345	0.398	0.453	0.508	0.565	0.622	0.680	0.739	0.799
52	.0737	.123	.173	.222	.271	.322	.375	.430	.484	.540	.597	.654	.713	.772
54	.0548	.104	.153	.202	.250	.301	.353	.407	.461	.517	.573	.630	.688	.746
56	.0352	.0844	.133	.180	.230	.280	.331	.384	.437	.493	.546	.603	.662	.719
58	.0190	.0648	.112	.159	.208	.258	.308	.360	.413	.467	.523	.577	.635	.692

refrigerant would be desirable under a given set of circumstances. For this reason various sets of tables* have been prepared for "Freon-11," -12, -21, -22, and -113, ammonia, methyl chloride, and water vapor. These tables enable the user to make rapid comparisons of the important basic data needed in deciding whether a refrigerant is suitable for a given set of circumstances. Temperatures are shown in degrees Fahrenheit.

The tables are easy to use. The temperature of the liquid ahead of the expansion valve is equal to the condensing temperature if no subcooling takes place. However, a small amount of subcooling usually takes place in most condensers. It is reasonably safe to figure that the temperature of the liquid ahead of the expansion valve will be about 5 F lower than the actual condensing temperature. The actual condensing temperature corresponding to any given head pressure can, of course, be found in the tables for saturated liquid.

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*See HPAC, June 1944, pp. 337-338, July 1944, p. 409, August 1944, pp. 478-480, and October 1944, pp. 593-594.

Methyl chloride—Volume of refrigerant to be compressed

(Saturated vapor leaving evaporator)

Cu ft per min per ton of refrigerating capacity

Evap Temp	Temperature of liquid ahead of expansion valve													
	60	65	70	75	80	85	90	95	100	105	110	115	120	125
-20	9.90	10.0	10.1	10.3	10.4	10.6	10.7	10.8	11.0	11.1	11.3	11.5	11.6	11.8
-18	9.44	9.55	9.67	9.79	9.92	10.0	10.2	10.3	10.4	10.6	10.8	10.9	11.1	11.2
-16	8.99	9.10	9.22	9.33	9.45	9.57	9.71	9.83	9.96	10.1	10.2	10.4	10.6	10.7
-14	8.58	8.68	8.78	8.90	9.01	9.13	9.25	9.37	9.50	9.64	9.77	9.91	10.1	10.2
-12	8.18	8.28	8.38	8.49	8.60	8.71	8.82	8.95	9.07	9.18	9.32	9.46	9.59	9.73
-10	7.81	7.90	8.00	8.10	8.21	8.31	8.42	8.54	8.65	8.77	8.89	9.02	9.16	9.29
- 8	7.46	7.55	7.64	7.74	7.83	7.93	8.04	8.15	8.27	8.37	8.50	8.61	8.74	8.87
- 6	7.12	7.21	7.30	7.39	7.49	7.58	7.68	7.78	7.89	7.99	8.11	8.23	8.34	8.47
- 4	6.81	6.89	6.98	7.06	7.16	7.25	7.34	7.44	7.54	7.64	7.75	7.86	7.97	8.09
- 2	6.51	6.59	6.67	6.76	6.84	6.93	7.02	7.11	7.21	7.31	7.41	7.51	7.63	7.74
0	6.23	6.31	6.38	6.46	6.54	6.62	6.71	6.80	6.90	6.99	7.09	7.19	7.29	7.40
2	5.96	6.04	6.11	6.18	6.26	6.34	6.43	6.51	6.60	6.69	6.78	6.87	6.97	7.08
4	5.70	5.77	5.85	5.92	5.99	6.07	6.15	6.23	6.31	6.40	6.49	6.58	6.68	6.77
6	5.46	5.53	5.60	5.67	5.74	5.81	5.88	5.96	6.04	6.13	6.21	6.30	6.39	6.48
8	5.24	5.30	5.37	5.43	5.50	5.57	5.64	5.72	5.79	5.87	5.95	6.04	6.12	6.21
10	5.02	5.08	5.14	5.20	5.27	5.34	5.41	5.48	5.55	5.63	5.70	5.79	5.87	5.95
12	4.81	4.87	4.93	4.99	5.05	5.12	5.18	5.25	5.32	5.39	5.47	5.55	5.62	5.71
14	4.62	4.67	4.73	4.79	4.85	4.91	4.97	5.04	5.10	5.18	5.24	5.32	5.39	5.47
16	4.43	4.48	4.54	4.59	4.65	4.71	4.77	4.83	4.90	4.96	5.03	5.10	5.17	5.25
18	4.25	4.30	4.36	4.41	4.47	4.52	4.58	4.64	4.70	4.76	4.83	4.90	4.96	5.04
20	4.09	4.13	4.18	4.24	4.29	4.34	4.40	4.45	4.51	4.57	4.64	4.70	4.77	4.84
22	3.92	3.97	4.02	4.07	4.12	4.17	4.22	4.28	4.34	4.39	4.45	4.51	4.58	4.65
24	3.77	3.82	3.86	3.91	3.96	4.01	4.06	4.11	4.17	4.22	4.28	4.34	4.40	4.47
26	3.62	3.67	3.71	3.76	3.80	3.85	3.90	3.95	4.00	4.06	4.11	4.17	4.23	4.29
28	3.49	3.53	3.57	3.61	3.66	3.70	3.75	3.80	3.85	3.90	3.95	4.01	4.07	4.12
30	3.36	3.39	3.44	3.48	3.52	3.56	3.61	3.65	3.70	3.75	3.80	3.85	3.91	3.97
32	3.23	3.27	3.30	3.34	3.39	3.43	3.47	3.52	3.56	3.61	3.66	3.71	3.76	3.81
34	3.11	3.14	3.18	3.22	3.26	3.30	3.34	3.39	3.43	3.48	3.52	3.57	3.62	3.67
36	3.00	3.03	3.06	3.10	3.14	3.18	3.22	3.26	3.30	3.35	3.39	3.44	3.49	3.54
38	2.88	2.92	2.95	2.99	3.03	3.06	3.10	3.14	3.18	3.22	3.27	3.31	3.36	3.41
40	2.78	2.81	2.85	2.88	2.92	2.95	2.99	3.03	3.07	3.11	3.15	3.19	3.24	3.28
42	2.68	2.71	2.74	2.78	2.81	2.85	2.88	2.92	2.96	2.99	3.04	3.08	3.12	3.16
44	2.58	2.61	2.64	2.68	2.71	2.74	2.78	2.81	2.85	2.89	2.93	2.96	3.01	3.05
46	2.49	2.52	2.55	2.58	2.61	2.64	2.68	2.71	2.75	2.78	2.82	2.86	2.90	2.94
48	2.40	2.43	2.46	2.49	2.52	2.55	2.58	2.62	2.65	2.68	2.72	2.76	2.80	2.84
50	2.32	2.35	2.37	2.40	2.43	2.46	2.49	2.52	2.56	2.59	2.62	2.66	2.70	2.73
52	2.24	2.26	2.29	2.32	2.35	2.38	2.41	2.44	2.47	2.50	2.53	2.57	2.60	2.64
54	2.16	2.19	2.21	2.24	2.27	2.29	2.32	2.35	2.38	2.41	2.45	2.48	2.51	2.55
56	2.09	2.11	2.14	2.16	2.19	2.22	2.24	2.27	2.30	2.33	2.36	2.39	2.43	2.46
58	2.02	2.04	2.07	2.09	2.11	2.14	2.17	2.19	2.22	2.25	2.28	2.31	2.35	2.38

Methyl chloride—Theoretical horsepower per cubic foot of vapor compressed per minute

Evap Temp	Condensing temperature													
	60	65	70	75	80	85	90	95	100	105	110	115	120	125
-20	0.102	0.108	0.114	0.120	0.126	0.132	0.138	0.144	0.150	0.155	0.161	0.167	0.172	0.178
-18	.103	.110	.116	.122	.129	.135	.141	.147	.153	.159	.165	.171	.177	.183
-16	.105	.111	.118	.125	.131	.138	.144	.150	.157	.163	.169	.175	.181	.187
-14	.106	.113	.120	.126	.133	.140	.147	.153	.160	.166	.173	.179	.185	.191
-12	.107	.114	.121	.128	.135	.142	.149	.156	.163	.170	.176	.183	.190	.196
-10	0.108	0.116	0.123	0.130	0.138	0.145	0.152	0.159	0.166	0.173	0.180	0.187	0.194	0.201
- 8	.109	.117	.125	.132	.140	.147	.155	.162	.170	.177	.184	.191	.198	.205
- 6	.110	.118	.126	.134	.142	.149	.157	.165	.173	.180	.188	.195	.202	.210
- 4	.110	.119	.127	.135	.143	.152	.160	.168	.176	.183	.191	.199	.206	.214
- 2	.111	.120	.128	.137	.145	.154	.162	.171	.179	.187	.195	.203	.211	.218
0	0.111	0.120	0.129	0.138	0.147	0.155	0.164	0.173	0.181	0.190	0.198	0.206	0.215	0.223
2	.111	.121	.130	.139	.148	.157	.166	.175	.184	.193	.201	.210	.219	.227
4	.111	.121	.131	.140	.150	.159	.168	.178	.187	.196	.205	.214	.223	.231
6	.111	.121	.131	.141	.151	.161	.170	.180	.189	.199	.208	.217	.227	.236
8	.111	.121	.131	.142	.152	.162	.172	.182	.192	.201	.211	.221	.230	.239
10	0.110	0.121	0.131	0.142	0.153	0.163	0.173	0.184	0.194	0.204	0.214	0.224	0.234	0.243
12	.109	.120	.131	.142	.153	.164	.175	.185	.196	.206	.217	.227	.237	.247
14	.108	.120	.131	.143	.154	.165	.176	.187	.198	.209	.220	.230	.241	.251
16	.107	.119	.131	.143	.154	.166	.177	.189	.200	.211	.222	.233	.244	.255
18	.106	.118	.130	.142	.154	.166	.178	.190	.202	.213	.225	.236	.247	.258
20	0.104	0.117	0.129	0.142	0.154	0.167	0.179	0.191	0.203	0.215	0.227	0.239	0.250	0.262
22	.102	.115	.128	.141	.154	.167	.179	.192	.204	.217	.229	.241	.253	.265
24	.0997	.113	.127	.140	.153	.166	.179	.193	.206	.218	.231	.243	.256	.268
26	.0972	.111	.125	.138	.152	.166	.180	.194	.207	.220	.233	.246	.259	.271
28	.0944	.109	.123	.137	.151	.166	.179	.194	.207	.221	.235	.248	.261	.274
30	0.0912	0.106	0.121	0.135	0.150	0.165	0.179	0.194	0.208	0.222	0.236	0.249	0.263	0.276
32	.0880	.104	.119	.133	.149	.164	.179	.194	.209	.223	.237	.251	.266	.279
34	.0840	.100	.116	.131	.146	.162	.178	.193	.208	.223	.238	.253	.267	.282
36	.0801	.0966	.113	.128	.144	.161	.177	.193	.208	.224	.239	.254	.269	.284
38	.0752	.0923	.109	.125	.142	.158	.175	.192	.208	.224	.239	.255	.270	.286
40	0.0707	0.0883	0.106	0.122	0.139	0.156	0.173	0.190	0.207	0.224	0.240	0.256	0.272	0.287
42	.0654	.0837	.102	.119	.136	.154	.171	.189	.206	.223	.240	.256	.273	.289
44	.0599	.0789	.0974	.115	.133	.151	.169	.187	.205	.222	.240	.256	.273	.290
46	.0539	.0735	.0926	.111	.129	.148	.166	.185	.203	.221	.239	.257	.274	.291
48	.0474	.0677	.0874	.106	.125	.144	.163	.183	.201	.220	.238	.256	.274	.292
50	0.0404	0.0612	0.0816	0.101	0.121	0.140	0.160	0.180	0.199	0.218	0.237	0.255	0.274	0.292
52	.0329	.0544	.0755	.0956	.116	.136	.156	.176	.196	.216	.236	.255	.274	.292
54	.0254	.0476	.0693	.0900	.110	.131	.152	.173	.193	.214	.234	.254	.274	.293
56	.0169	.0400	.0621	.0835	.105	.126	.147	.169	.190	.211	.231	.252	.273	.292
58	.00941	.0318	.0542	.0759	.0984	.120	.142	.164	.186	.208	.229	.250	.271	.291

BEHIND THE DRY RESEARCH REPORT SUMMARIZING FACTUAL DATA AND PRESENTING QUALIFIED CONCLUSIONS OFTEN LIES A WARMLY HUMAN BACKGROUND OF INTEREST NOT SO MUCH TO ENGINEERS AS ENGINEERS, BUT TO ENGINEERS AS PEOPLE. THIS MONTH WE TRAVEL THE SOUTH PACIFIC. THE SKETCHES ARE BY KAY HUTCHINSON

Background for Research: South Pacific

By F. W. Hutchinson*

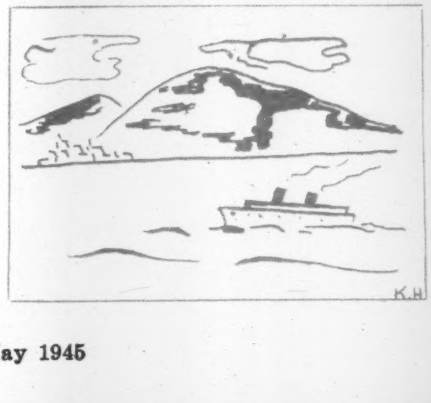
To be forced to jump out of the way of a moving automobile is at best an undignified experience; to be assailed by a driverless car is even more annoying; but to find it necessary to leap from the path of a driverless car at the point on the earth's surface farthest from land is, beyond doubt, the nadir of undignified procedure. Yet just such a traffic hazard occurred in 1941 while working on a marine heat transfer research project. The story is somewhat confused and one cannot always separate cause from effect, but in the most general terms it now seems probable that the difficulty can be indirectly attributed to a Hawaiian New Year's Eve party.

Didn't Attend The Party

The writer, unfortunately, did not attend the party. Instead, he was busily shepherding across the Pacific Ocean a valuable potentiometer, a group of plate type heat meters, many thermocouples, and an unwieldy bundle of 20 ft lengths of ¼ in. black pipe. The passenger vessel on which this equipment was being carried was due to arrive in Honolulu shortly after New Year's Day of 1941 and the research equipment was then to be transferred to a large freighter. Plans had been thoroughly arranged in advance — schedules carefully checked — and the freighter was to leave Oahu on the return trip to San Francisco, carrying bulk cargo in a completely instrumented deep-hold.

The pipe had been brought along to provide a shielding for thermocouple leads which would extend down some 40 ft into the hold. Thermocouples were to be placed at intervals throughout the mass of the bulk cargo so that it would be possible to determine both vertical and horizontal temperature gradients. The heat meters were to be placed—inside battens—against the ship's plates where they would give the actual rate of energy loss from the hold while a time-temperature plotting of the various thermocouple readings was expected to permit evaluation of the rate at which energy was leaving storage in the cargo. Thus data would be collected from which a direct experimental check would be possible on the accuracy, under actual maritime conditions, of some of the analytical procedures which had been advocated for use in solving transient heat flow problems in ship cargo spaces.

In preparation for the project, Hydrographic Office charts had been studied for the preceding 10 year period and curves developed which were thought to represent the probable time-temperature relationship for air temperatures and sea temperatures during the first week in January and for the passage from Honolulu to San Francisco. The sizes and complete heat transfer characteristics of the ship on which the tests were to be run were, of course, determined well in advance; complete calculations had been made of the expected cooling curves for the cargo. All that remained was to collect the experimental data, reduce it to standard form, and compare the actual cooling curves with those which had been developed analytically.



A Problem of Instruction

As a means of realizing the maximum of experimental effectiveness from the one voyage, it was expected that one deep-hold could be stowed under conditions representative of bulk storage while a portion of the 'tween-deck space was to be filled with loosely stowed package cargo. Thus—by a judicious location of thermometers, heat meters, and thermocouples — data would be obtained from the one trip which would permit checking both the Schmidt and Holme theoretical methods of transient heat flow analysis. But these were the plans as they existed prior to the party.

The party occurred somewhere in Honolulu on New Year's Eve. Probably *all* the dock workers of the nearby vicinity did not attend, but this is merely a matter of conjecture. Certainly most of them did. In any event, practically no one appeared for work on January 2. And thus it came about that when the passenger vessel carrying potentiometer, heat meters, thermocouples, ¼ in. pipe, and the researcher actually did reach Honolulu it was only to find that the large freighter on which the return trip had been planned was still waiting—empty—at the dock.

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Under the circumstances the most sensible thing would have been to spend a few days swimming at Waikiki while waiting for the freighter to be loaded. But university schedules had to be met and it was necessary to leave Honolulu almost immediately and by whatever means was available. A smaller freighter was scheduled to leave at dawn the following morning so arrangements were made to gain passage and to arrange for at least a crude form of instrumentation in the ship's forward hold. In conference with the first officer of the vessel and the stevedore foreman, it was agreed by the latter that sufficient space would be left between flanges of the vertical H columns which passed down through the deep-hold to permit insertion in the nethermost parts of the hold of sections of thermocouple-bearing ¼ in. pipe. All arrangements having been satisfactorily made, the researcher went on to the Royal Hawaiian to listen to Mr. Owens and to investigate the hydrodynamic characteristics of surf boards.

The following morning, as the ship left Diamond Head in the background, thermocouples were threaded through the ¼ in. pipe and all arrangements were made for establishing adequate instrumentation in the No. 1 hold. Since the hatch cover was battened down, it was necessary to go into the 'tween deck space from a position aft of the bridge, then work forward through the cargo filled deck space. Cargo in the 'tween deck consisted largely of empty, neatly stacked, beer kegs being returned to the mainland, cases of pineapple or pineapple juice and, in one isolated section which had otherwise been left empty—doubtless because of the Honolulu party—a new and highly polished automobile was securely lashed with its rear bumper against the starboard side of the ship.

With the help of a flashlight and two members of the crew, No. 1 hold was finally reached and the pipe brought down through a small rent in the hatch cover. Then the problem was to insert the long lengths of pipe in the small openings beside vertical H columns. But when the light was flashed on the H columns, the openings appearing were by no means small. Instead of the expected 2 or 3 in. space between flanges, someone had managed to shore the cargo back for a radius of 2 ft around each column! In place of a small opening through which the pipe could be inserted and from which one could hope to learn the vertical temperature gradient through the mass of the cargo, there were what amounted to elevator shafts at intervals throughout the hold. Obviously the convection currents set up in such large openings would make air temperature thermocouple readings practically meaningless and assuredly they could not be used as a valid indication of the actual temperature of the mass of cargo. Months of work gone for nothing!

Wagnerian Baritone

Later on the first officer was questioned as to the reason for the roominess. He sounded like a Wagnerian baritone: "Vell," he said, "didn't you say that you vanted space beside the H columns? Didn't ve give it to you? Ve sacrificed good cargo to leave room for you to go down to the double bottom to play with your toys. Yet you are not satisfied?" Needless to say the moral is that months of difficult preparation serve for nothing if you can't—when the time comes—say what you mean. Or is the moral that an engineer should not swim — or listen to Mr. Owens?

Rum and Coca Cola may have its merits, but beer and pineapple juice is, at best, a nauseous mixture. During the 48 hours that a thoroughgoing January storm continued, readings had to be taken of all thermocouples, heat meters, etc., at 2 hr intervals. To get forward to the No. 1 hold required going through the 'tween deck space of all that section of the ship which was forward of the bridge. In calm weather this walk was restricted and uninteresting, but once the storm really broke it became a veritable nightmare.

Beer and Pineapple Juice

The neat piles of empty beer kegs literally disintegrated so that individual prowling kegs were to be met with at very unexpected times. In addition, the dissolution of the neat piles led to the knocking out of bungs with a consequent drenching of the deck with dregs and a stifling odor of stale beer. To add to the chaos, a few cans of pineapple, or of pineapple juice, had been broken and the sickly sweet smell added to the odor problem while the sticky syrup dripped from above into one's hair and at the same time made the deck so slippery that—with a rolling ship — each step was a hazard.

Under the circumstances not much more could be expected to happen. And nothing did. At least not until the ship reached a point exactly halfway between Honolulu and San Francisco. Someone has written that this is the point on the earth's surface which is farthest from land. It probably is. And at exactly this point the lashings broke on the automobile which was being carried back to the mainland. Each time the ship would roll the car would run across the deck and undergo a slight compressing effect as it met the plates on the other side. The research problem was a simple one: Merely to time one's actions so as to slide — on beer and pineapple juice — across the slippery deck during the interval in which the automobile reached

SURVEY OF AIR CONDITIONING "TROUBLES" WOULD BE VALUABLE

I am of the opinion that the purely scientific side of air conditioning has been well taken care of in all our literature. Magazine articles and technical papers have developed the higher mathematics side of air conditioning to a high degree.

I am also of the opinion that the good old common-sense side of installation problems and operating results has not kept pace with the technical side.

It would seem to me that perhaps some surveys of existing installations could well be undertaken to develop the trials and tribulations thereof from which to formulate specific design do and don't information for the mechanical engineer or draftsman, who, in the last analysis, has the responsibility of the final layout of the equipment ducts and piping systems.

Such a survey might also spotlight the need for more simplicity and less elaborate control. If such a survey could also gather cost data, it would be still more valuable.—O. W. OTT, consulting mechanical engineer.

"dead end" and paused before starting its return journey. And all for the sake of obtaining data which could probably never be used since the conditions of the experiment were not well controlled and the variables could not be effectively isolated.

Although the test data did not permit use in the method which had been planned, they were useful in setting up a basic procedure for analysis of condensation problems. As a "full size" laboratory for test work on condensation the Honolulu-San Francisco run is particularly well suited, since it offers fairly stable water and air temperatures and a seasonal variation which can be anticipated with excellent accuracy. The maximum difference in night air temperature between Honolulu and San Francisco is approximately 18 F (in December and January) while the minimum (in August and September) is 12 F. Maximum range of sea water temperatures is also 18 F (June, July) while minimum is 12 F (December, January). For purposes of experimentally checking analytical procedure the average variation of both sea and night air temperatures can be taken as 15 F—from 60 F at San Francisco to 75 at Honolulu.

Down Under

Another marine research project involved a 17,000 mile, seven week trip to Samoa, the Fiji Islands, New Zealand, and Australia. Primarily the project was undertaken in order to collect data on the performance, under highly variable operating conditions, of marine refrigeration and air conditioning equipment. Aside from the purely technical aspects of this project, a number of rather interesting sidelights were encountered. Among these were:

Sigma Heat Content

1) As a result of a ship sinking —due to enemy action—the large passenger vessel on which the research was being conducted was delayed in reaching a Polynesian port of call. The natives had collected tropical fruit in anticipation of the ship's arrival and, when it didn't come, they protected their investment as best they could by erecting a loose grass barricade on the windward side of the storage pile, moistening it to secure some degree of evaporative cooling. The fruit was thereby subject to air of higher relative humidity (so it would dry less rapidly) and lower dry bulb temperature (so it would spoil less rapidly). Doubtless the natives did not know the theory of psychrometrics, but like Chaucer's pilgrim (who put a wetted palm leaf on his head, " for to keep his head from heat,") they had learned by experience that the Sigma heat content remains practically constant during the process of adiabatic saturation.

2) On one of the islands an unfortunate Britisher was encountered who had installed a refrigerating machine shipped all the way from England. It was a carbon dioxide unit and was located in a region where the temperature of available cooling water exceeded the critical temperature of the refrigerant.

3) An interesting example of acclimatization was observed on the outward trip. Of the hundreds of passengers going to Australia, most were Americans and were acclimated to weather such as exists in most parts of the United States during late spring. As the ship passed through the tropics a majority of these passengers still preferred that the air conditioned main dining saloon be held at a temperature close to 72 F. At Fiji a large number of British colonials boarded the ship to take passage to New Zealand and Australia. Immediately the operating engineer's problems increased as the Fiji residents complained bitterly of the low air temperature while the Americans entered vehement protest if the saloon temperature was raised sufficiently to permit the newcomers to attain comfort. The final compromise was to establish a saloon temperature too hot for one group, but too cold for the other; thus everyone was eventually uncomfortable.

HUMIDITY CONTROL SPEEDS BUTTON OUTPUT

Plastic olive drab buttons for clothing of men and women in the armed forces are now being made with fewer rejects, savings in strategic materials, and less production difficulties in conditioned air. Machine-made from a fine powder, production delays were encountered on humid days, when the moisture in the air caused the powder to stick to the sides of the molds, causing waste and production delay. Air pockets also formed, resulting in a higher number of rejects. Engineers of Carrier Corp. studied the problem and an air conditioning system was installed which eliminated the difficulty. Now the production of buttons is independent of the weather, and production schedules are maintained.

Using the Velocity Head Concept in

PRESSURE DROP CALCULATIONS

In the calculation of pressure drops or friction losses, the utility of the velocity head concept lies in the fact that the pressure drop or friction loss can generally be expressed as a certain number of velocity heads, which is a dimensionless ratio. The actual pressure drop or friction loss can then be calculated from the velocity head and will have the same units as the velocity head. In turbulent flow, pressure drop represents largely a decrease in potential energy to develop a specific kinetic energy which may subsequently be dissipated as heat by impact or general turbulence or may be, at least partially, recovered as pressure if the fluid subsequently expands or decelerates. A small portion of the pressure drop may be directly due to frictional shearing between fluid layers. Where this is an appreciable factor, the pressure drop will be found to be a function of the Reynolds number. Where this is a negligible factor and pressure drop is due almost entirely to a deceleration or acceleration of the fluid, the pressure drop will be substantially independent of the Reynolds number. For conditions commonly encountered in practice, the flow through pipes, tube banks, and granular solids illustrates the first case, where frictional losses are appreciable even though the flow pattern is turbulent, while the flow through orifices and nozzles represents the latter case, where frictional losses are negligible. For the latter case, the pressure drop expressed as a number of velocity heads will be substantially constant and independent of the Reynolds number. Whereas the pressure drop expressed as number of velocity heads will vary somewhat with the Reynolds number for the first case, it can be approximated by a constant value within reasonable limits of accuracy over the usual Reynolds number range encountered in practice.

In the following paragraphs, the conventional pressure drop and friction loss equations will be presented in terms of velocity head together with an interpretation of their physical significance. It is assumed in these developments that the fluid density does not undergo any appreciable (more than 20 per cent) change in flowing through the pipe or apparatus under consideration so that an average density can be employed. When large density changes occur, such as are encountered in the flow of gases at high pressure drops, special methods of calculation are required. [See C. E. Lapple, Trans. Am. Inst. Chem. Engrs., *39*, 385-432 (1943).]

Friction Loss in Pipes

The friction loss or pressure drop in straight horizontal circular pipes is generally expressed in terms of the Fanning equation:

$$F = \Delta p = (4fL/D)\ (\rho V^2/2g_c) \quad \ldots.[7]$$

where f is a function of the Reynolds number as shown in Fig. 4. It will be observed that the second group of terms in parentheses represents the velocity head, so that Equation 7 may be rewritten as

$$\Delta p_v = \Delta p/(\rho V^2/2g_c) = (4fL/D) \quad \ldots\ldots\ldots.[8]$$

where the pressure drop is expressed as a certain number of velocity heads, given by $(4fL/D)$. From Equation 8 it is apparent that the length of pipe expressed as number of pipe diameters $(L/D)_v$, for which the pressure drop corresponds to one velocity head (i.e., for which $\triangle p_v = 1$) is given by

$$(L/D)_v = 1/(4f) \quad \ldots\ldots\ldots.[9]$$

In the process industries as well as in the ventilating field, actual designs will generally lie in the Reynolds number range of 5000 to 1,000,000. Inspection of Fig. 4 will show that in this range the friction factor, f, only varies over the range of 0.004 to 0.010 for clean commercial steel pipe. An average value of 0.0055 is a good approximation for rough estimates over the entire range and the corresponding value of $(L/D)_v$ as found from Equation 9 is 45. In other words, the pressure drop for 45 pipe diameters of clean commercial pipe is one velocity head within ± 40 per cent. This will be recognized as a common rule of thumb in the ventilation field. Water handling problems generally involve a range in Reynolds number of 10,000 to 100,000, while air handling problems usually fall in the range 50,000 to 1,000,000. It is apparent from Table 2 that, allowing for the maximum probable variation in f for new steel pipe, the length of pipe for which the pressure drop is equal to one velocity head may range from 25 to 65 pipe diameters, though, for most practical cases, it ranges from 30 to 45 pipe diameters for water lines and from 40 to 65 pipe diameters for air lines. Thus, within ± 25 per cent, $(L/D)_v$ may be taken as 40 and 50 for water and air handling, respectively.

While the previous discussion has dealt with flow through circular pipe, the same equations and friction factors will also apply to noncircular pipe for turbulent flow provided the diameter term, D, used in calculating (L/D) or Re is replaced by the hydraulic diameter, D_h. The velocity and velocity head, however, must be based on the actual cross-section of the pipe considered.

Pressure Drop Through Fittings and Valves

The pressure drop through fittings and valves in turbulent flow can be expressed either in terms of an equivalent length of straight pipe of the same nominal size or as a certain number of velocity heads in the pipe of the same nominal size as shown in Table 3. While these two methods are not entirely comparable and will yield slightly different answers, both methods give results which are well within the accuracy of available data and within variations due to differences in specific structural details of commercial fittings and valves. For Reynolds numbers less than 100,000, the equivalent length values give a more accurate correlation of data on a specific fitting or valve, whereas for larger values of the Reynolds number the equivalent velocity head is more accurate. However, all the values of Table 3 are probably good to better than ± 30 per cent, and represent averages of the data reported in References 13-20.

Friction Loss Across Tube Banks

The friction loss or pressure drop across tube banks is commonly expressed as

$$F = \Delta p = (4 f_1 N) \; (\rho V^2_{\text{max.}}/2g_c) \quad ..[10]$$

where f_1 is a form of friction factor which is a function of the Reynolds number. For tube banks the Reynolds number is usually expressed either as $(D_t V_{\text{max.}} \rho/\mu)$ or $(D_c V_{\text{max.}} \rho/\mu)$, the two being directly related in terms of the configuration of the tube bank. The maximum velocity between tubes, $V_{\text{max.}}$ is defined as the velocity based on the smallest free total area through which all the fluid must pass, whether this be between tubes in a row normal to the general flow direction (for all in-line and some staggered arrangements) or along the diagonal openings between tubes in adjacent rows (for staggered arrangements with very close row spacings). The term D_c is defined as the clearance between tubes corresponding to this minimum flow area. For all in-line arrangements and most staggered arrangements commonly encountered in practice, $V_{\text{max.}}$ and D_c will be based on the free area and clearance between tubes in a row normal to the general flow direction. In the subsequent discussion of tube banks, the Reynolds number will be defined as $(D_c V_{\text{max.}} \rho/\mu)$.

By C. E. Lapple*

DESIGN OF pipe lines, process equipment, ventilation systems, etc., requires estimation of pressure drops in order to specify the required pump, compressor, fan, or blower capacities. Pressure drop estimates are often necessary, too, in the operation of equipment for purposes of locating possible plugged or corroded lines, checking process performance, or determining bottlenecks for proposed capacity increases. The article of which this is the second part (the first was published in the April issue) is intended as a guide to a physical conception or visualization of otherwise seemingly complex fluid flow phenomena. The approximations presented will be found to be entirely adequate for many purposes, and an attempt has been made to point out their limits of accuracy.

Nomenclature

D = Inside diameter of circular pipe, ft;
D_c = Clearance between tubes in a tube bank, ft;
D_h = Hydraulic diameter = 4 × cross-sectional area ÷ "wetted" perimeter = D for circular pipe;
D_p = Diameter of granular particle, ft;
D_t = Outside diameter of tubes in a tube bank, ft;
E_v = Kinetic energy of fluid (ft-lb force)/(lb mass);
f = Fanning friction factor for flow in conduits, dimensionless;
f_1 = Friction factor for flow across tube banks, dimensionless;
f_2 = Friction factor for flow through beds of granular solids, dimensionless;
F = Friction loss (lb force)/(sq ft)†
g_c = Conversion factor, 32.17 (lb mass/lb force) (ft/sec²);
L = Length of straight horizontal pipe or depth of bed of granular solids in direction of flow, ft;
L_e = Equivalent length of straight pipe of same nominal size as valve or fitting, ft;
$(L/D)_v$ = Length of straight pipe, expressed as number of pipe diameters, for which pressure drop is one velocity head (i. e., for which $\Delta p_v = 1$), dimensionless;
N = Number of rows of tubes normal to general direction of flow, dimensionless;
p = Fluid pressure, (lb force)/(sq ft);
p_v = Velocity head, (lb force)/(sq ft);
Δp = Pressure drop, (lb force)/(sq ft);
Δp_v = Pressure drop, number of velocity heads, dimensionless;
R_e = Reynolds number, dimensionless = $(DV\rho/\mu)$ for flow through pipes, orifices, nozzles, or venturis; $D_c V_{\text{max.}} \rho/\mu)$ for flow across tube banks; $(D_p V \rho/\mu)$ for flow through beds of granular solids;
V = Average fluid velocity, (ft/sec);
$V_{\text{max.}}$ = Maximum average fluid velocity in flow across tube banks, (ft/sec);
ρ = Fluid density, (lb mass) /(cu ft);
μ = Fluid viscosity, (lb mass)/(ft) (sec) = centipoises ÷ 1488.

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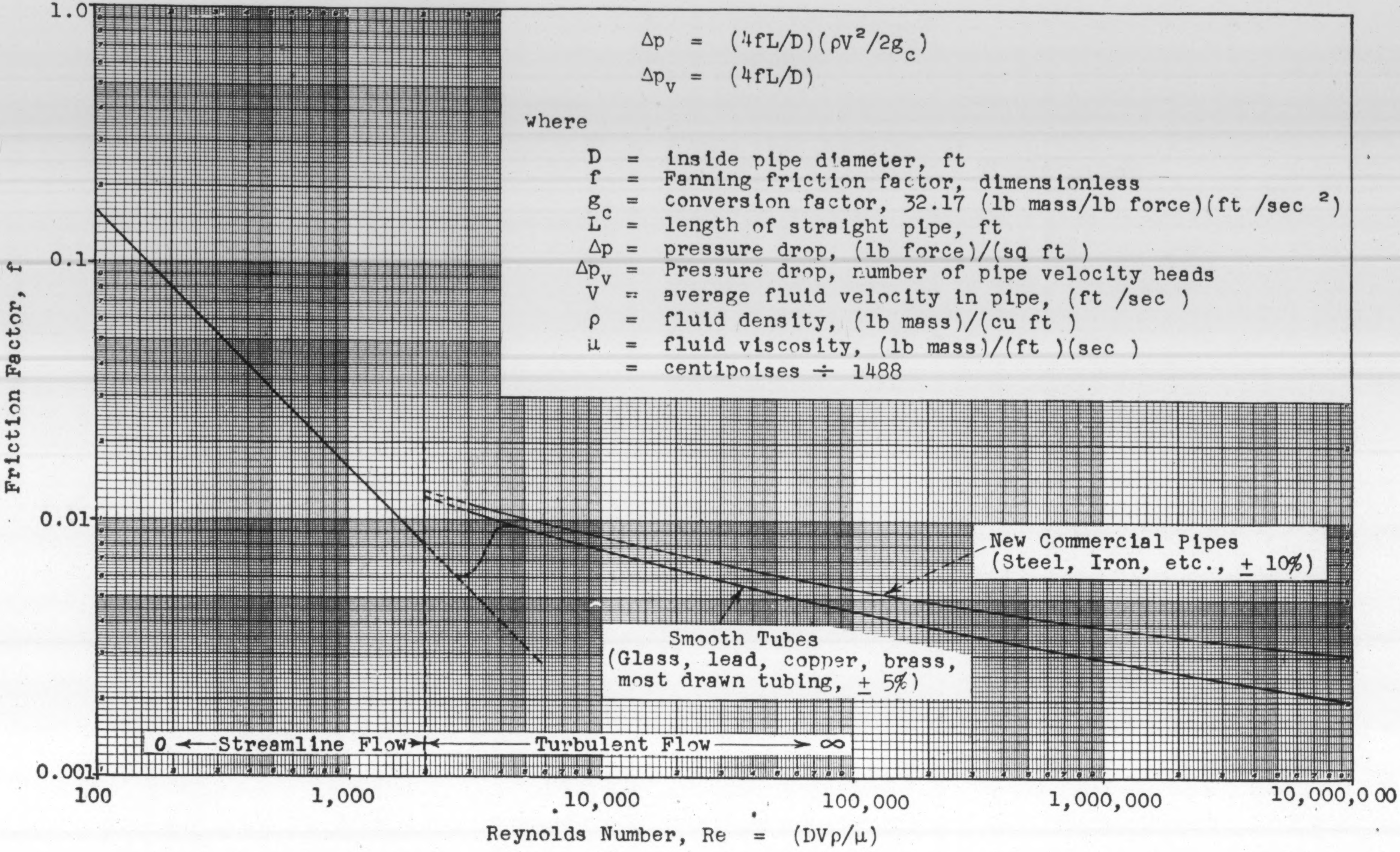
†Friction loss is often defined as an energy loss per unit mass of fluid, having the dimensions (ft-lb force)/(lb mass). This definition of friction loss is equivalent to the quotient F/ρ.

*Engineering Dept., Chemical Engineering and Metallurgical Laboratory, Experimental Station, E. I. du Pont de Nemours & Co., Inc.



$$\Delta p = (4fL/D)(\rho V^2/2g_c)$$

$$\Delta p_v = (4fL/D)$$

where

D = inside pipe diameter, ft
f = Fanning friction factor, dimensionless
g_c = conversion factor, 32.17 (lb mass/lb force)(ft /sec ^{2})
L = length of straight pipe, ft
Δp = pressure drop, (lb force)/(sq ft)
Δp_v = Pressure drop, number of pipe velocity heads
V = average fluid velocity in pipe, (ft /sec)
ρ = fluid density, (lb mass)/(cu ft)
μ = fluid viscosity, (lb mass)/(ft)(sec)
= centipoises ÷ 1488

Fig. 4—Friction factor—Reynolds number plot for flow through straight circular smooth and commercial pipe (References 3, 6, and 10)

Table 2—Values of $(L/D)_v$ for New Commercial Pipe

Reynolds Number	Corresponding Value of f	$(L/D)_v$
5,000	0.0101	25
20,000	0.0075	35
50,000	0.0062	40
100,000	0.0054	46
1,000,000	0.0039	64

Equation 10 may be written in terms of velocity head as

$$\triangle p_v = \triangle p/(\rho V^2_{max.}/2g_c) \quad \ldots [11]$$

where the velocity head is based on the maximum fluid velocity between tubes. The term f_1 is a function of tube arrangement and spacing as well as of the Reynolds number and for more detailed data the reader should refer to References 23-27. Fig. 5 gives a plot of f_1 vs. *Re* taken from a correlation given by Chilton and Genereaux (see Reference 22). In this plot the friction factor represents average values for the range of spacings commonly encountered in practice. To avoid possible misusage, it should also be pointed out that the line for the streamline flow region (*Re* less than 25) is shown on this basis merely for simplicity. This line represents the available streamline flow data for two staggered arrangements within ±40 per cent only and a better correlation in terms of hydraulic diameter is available (Reference 22). For Reynolds numbers expressed as $(D_c V_{max.} \rho/\mu)$, greater than 100, the term f_1 has an average value of 0.18 and 0.08 for staggered and in-line arrangements, respectively, which is good to better than ±50 per cent for tube spacings commonly encountered in practice. For these average values of f_1, Equation 11 becomes

For staggered tubes:

$$\triangle p_v = 0.72\ N \quad \ldots\ldots\ldots\ldots [12]$$

For in-line tubes:

$$\triangle p_v = 0.32\ N \quad \ldots\ldots\ldots\ldots [13]$$

which means that each row has a pressure drop of 0.72 velocity head based on the maximum velocity for staggered rows, and 0.32 velocity head for in-line rows.

For a single row of tubes or for a tube bank of either staggered or in-line arrangement with a longitudinal spacing of more than five tube diameters, the flow would correspond to that of a number of rectangular nozzles in parallel. The pressure drop from the front of the tube to the point of minimum flow cross-section would be expected to be 1.0 velocity head. Some pressure recovery would then take place when the fluid expands again behind the tube. The overall pressure drop will then be given by Equation 24, which will be discussed in the section on metering devices. For actual arrangements, however, the longitudinal spacing is usually less than 2.0 tube diameters and the above equations, giving the average pressure drop per row for a tube bank of more than five rows deep, reflect the influence of the rows upon each other. Thus, if the second row is close to the first row, the pressure drop through the second row will be less than for the first row since the fluid still retains some of its high kinetic energy upon entering the second row, so that less pressure drop is required to again accelerate the fluid. Wallis and White (Reference 27) have given quantitative confirmation of the above statements and have shown that the pressure drop across the first row of tubes is the same for in-line or staggered arrangements. For in-line arrangements, close longitudinal spacing will decrease the apparent pressure drop per row, whereas for some staggered arrangements, the apparent pressure drop may increase because of prevention of complete pressure recovery behind the tube.

In practical application to baffled heat exchangers, the actual pressure drops may be as little as 0.1 of the pressure drop calculated from the above equations, because of leakage through the clearance between tubes and baffles (see Reference 21).

For baffled exchangers, the pressure drop across the baffles will depend on the tube configuration and very meager data are available. For most purposes, however, the pressure drop for flow around the baffle may be taken as 2.0 velocity heads based on the free area available for flow around the baffle (Reference 3, page 828).

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Table 3—Pressure Drop Through Screwed Fittings and Valves (for Turbulent Flow Only)

D = Actual internal diameter of pipe of same nominal size as fitting, ft;
L_e = Equivalent length of straight pipe of same nominal size as fitting, ft;
$\triangle p_v$ = Pressure drop, equivalent number of velocity heads based on velocity in pipe of same nominal size.

Type of Fitting or Valve	(L_e/D)	Δp_v
45 deg Elbow, standard	15	0.3
45 deg Elbow, long radius	10	0.2
90 deg Elbow, standard	32	0.74
medium radius	26	0.60
long sweep	20	0.46
square	60	1.3
180 deg Bend, close return	75	1.7
medium radius	50	1.2
Tee, standard, (along run, branch blanked off)	20	0.4
(used as elbow, entering run)	60	1.3
(used as elbow, entering branch)	70	1.5
(branching flow)	..	1.0**
long radius (used as elbow, entering run)	30	0.5
Couplings	2	0.04
Unions	2	0.04
Gate valves,* open	7	0.13
¾ open	40	0.8
½ open	200	3.8
¼ open	800	15.0
Globe valves,* bevel seat, open	350	6.3
½ open	550	10.0
composition disk, open	330	6.0
½ open	500	9.0
plug disk, open	500	9.0
¾ open	700	13.0
½ open	2000	35.0
¼ open	6000	110.0
Angle valves,* open	170	3.0
Y or blowoff valves,* open	170	3.0
Check valves, swing	110***	2.0***
disk	500***	10.0***
ball	3500***	65.0***
Water meters, disk	400	8.0
piston	600	12.0
impulse wheel	300	6.0

*Direction of flow of fluid through valves has a negligible effect on pressure drop.

**This value refers to the velocity head in the main stream before branching. Depending on the relative flow split, this value ranges from 0.7 to 1.3 where the main flow enters the run and from 0.9 to 1.5 where the main flow enters the branch. This value gives the pressure differential (not friction loss) between run and branch.

***These values apply only when the check valve is fully open. The wide open condition is generally attained for pipe velocities over 3 ft/sec when handling water.

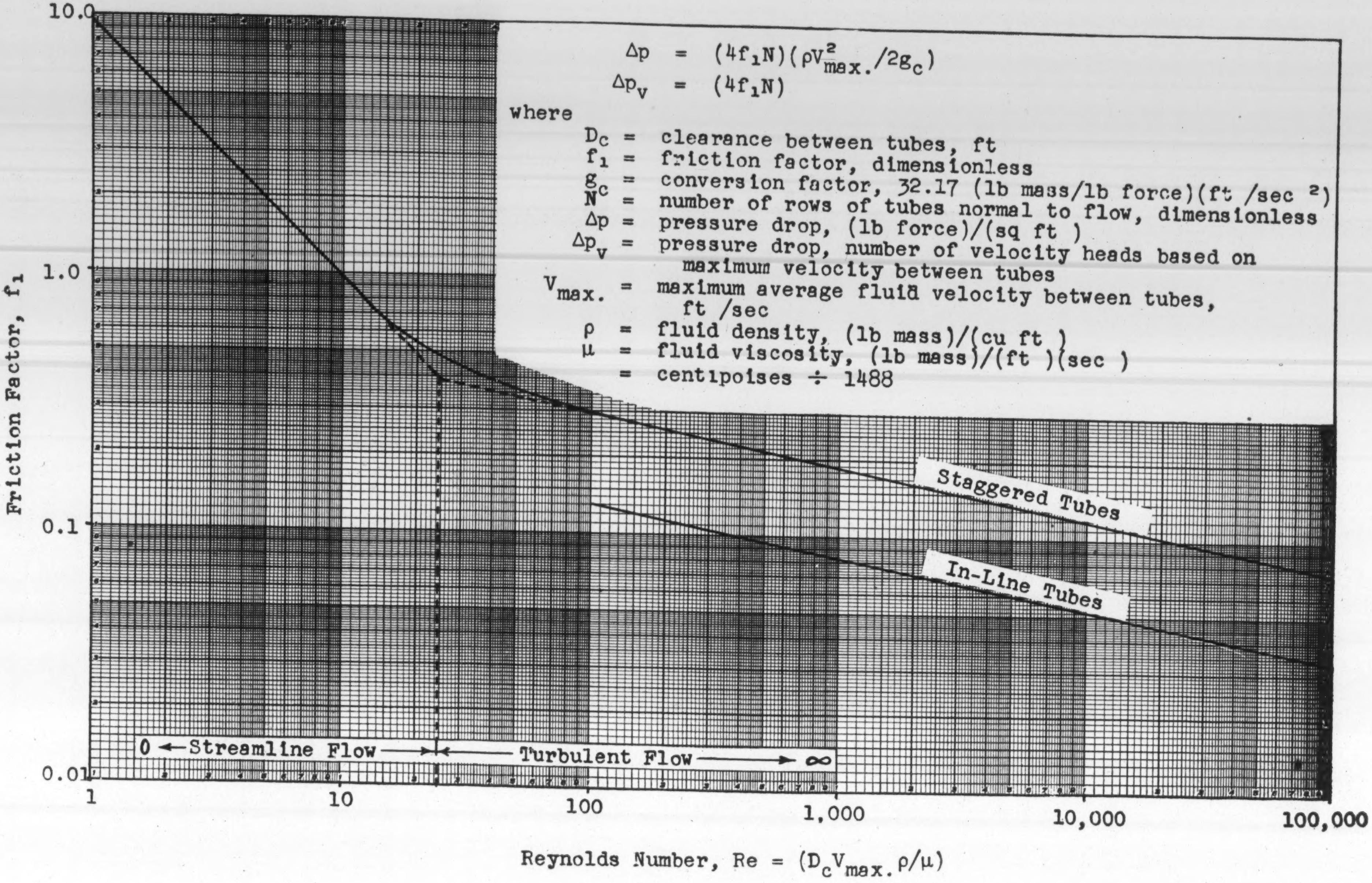

Fig. 5—Friction factor—Reynolds number plot for flow across tube banks. (Average value for tube spacings and arrangements commonly encountered—Reference 22)

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ABSTRACTS OF ENEMY PATENTS AVAILABLE

The publication of two sets of abstracts or short descriptions of 45,000 alien owned U. S. patents seized by the Alien Property Custodian of the United States government has been announced by James E. Markham, the custodian.

These patents were developed by our enemies at a cost of millions of dollars and involved millions of man-hours of work. They contain many items which may be of value in prosecuting the war and also for postwar use. The patents cover practically every field of manufacture. Licenses to most of these patents are available to American citizens at a nominal fee of $15 per patent and are good for the life of the patent.

To help find items of particular interest, the abstracts have been classified and indexed. The mechanical and electrical abstracts (about 37,000 patents) consist of a short description and an illustrative drawing. The chemical abstracts (about 8000 patents) consist of a condensed description of the chemical principle involved. Each set of abstracts sells for $25 and may be obtained from the Office of Alien Property Custodian, 311 Field Building, Chicago 3, Ill.

If the complete sets of abstracts are not desired, portions of them (sections or classes dealing with any one subject) are obtainable at proportional cost. An index showing the section or class titles and prices may be obtained free of charge by writing to the Alien Property Custodian.

ASKS BETTER HEATING, VENTILATING IN FOUNDRIES

Six months would be needed to fill the unfilled orders for radiation if no new orders were placed, according to information presented to the War Production Board's cast iron boiler and radiator labor advisory committee by WPB officials, WPB reported in February.

The government spokesmen said that production—which was 25 per cent below schedule in 1944—was continuing to decline, in the face of expected sharp increases in civilian and military requirements for 1945. Estimates indicated that approximately 3,250,000 sq ft of radiation will be needed for the veterans' hospitals program.

Minimum radiation requirements for 1945 are 25 per cent of pre-war output, WPB said. Actual production last year was approximately 20 per cent of normal peacetime output.

The labor advisory committee declared that the chief stumbling block to increased production is "intolerable" working conditions. The committee made the following recommendations for improvements: (1) ventilating systems to remove gases and smoke; (2) proper heating of the foundries; (3) lockers where clothes can be kept dry; (4) showers and washrooms; (5) lunchrooms, or at least space set aside for eating; (6) sanitary toilets, and (7) safety regulations.

GOOD DEAL

Duke Ellington's band has been featuring a number entitled Air Conditioned Jungle.

● WPB . . . OPA . . . PAW . . . Etc. ●

Fuel Supplies Still Will Be Limited Next Winter, Says Ickes

Published assertions that either fuel oil or coal supplies for civilians will be more plentiful next winter than last are untrue and mislead consumers, the Petroleum Administration for War and the Solid Fuels Administration announced in a joint statement issued May 3.

Secretary of the Interior Harold L. Ickes, who administers both agencies, said:

"We hope to have enough home heating oil to supply present consumers next winter with as much fuel oil as they had in the last heating season, but there will not be more. There may be even less. To say that it will be more plentiful is certainly erroneous. And there is no likelihood that coal users whose quotas have been reduced can turn to fuel oil for relief.

"The defeat of Germany will not end fuel shortages. Coal supplies will be deficient because of decreasing mine manpower, and fuel oil for civilian use will be restricted by heavy military requirements in waging war against the Japs.

"Fuel oil consumers, on the average, have been getting about 75 per cent of their normal supply. Domestic consumers of eastern mined coal or byproduct coke are limited to 80 per cent of their customary annual requirements. Those who burn coal mined in other parts of the country should be able to get a better supply if they order and store their coal this spring and summer, while it can be readily supplied.

"It is essential that all consumers of coal, byproduct coke, and other solid fuels east of the Mississippi river and in Iowa and Minnesota properly fill out and file their consumer declarations, together with their orders, with their dealers at once. Those who delay may have difficulties in getting their fuel next winter.

"Extremely heavy burdens are placed upon the coal industry by essential war plants and domestic consumers alike. These burdens were made heavier by the conversion of heating equipment to the use of coal instead of fuel oil, byproduct coke, and wood. Supplies of both solid and liquid fuels will be so limited that we can afford no relaxation of our efforts to conserve them wherever possible, and there can be no conversion from use of either fuel to the other."

Adjust Burners for Heavier Oils, PAW Advises

Next winter's heating oil probably will be of a slightly heavier grade than was available last winter, Deputy Petroleum Administrator Ralph K. Davies reported May 2 in an appeal to consumers to get their oil burners in peak-performance condition during the next few months.

Cleaning of furnaces and burners, always advisable from the standpoint of economy and comfort, is more necessary than ever because of the effect war demands have had on domestic grades of fuel oil, he said, and in some cases, as in past years, adjustment of units may be required to adapt them to present day oils.

This year's oil, according to Mr. Davies, will be a satisfactory heating fuel and will perform at a high rate of efficiency in the vast majority of burners, if they are kept in good condition.

The lighter fuel oil in common use prior to 1942, he said, has gone to war in an extremely vital and large-scale way. It is going into diesel oil used for land, sea, and amphibious operations and into the manufacture of high octane gasoline for combat and supply planes.

As a result of the drain caused by diesel oil and aviation gasoline requirements a large proportion of the oil now available for heating is the "cracked oil" remaining from the manufacture of aviation gasoline. This, while somewhat heavier than the oil used normally, contains more heating units per gallon.

Fortunately, Mr. Davies pointed out, the majority of burners can be adjusted to operate at a high degree of efficiency with the heavier oil. Many of them actually can be tuned for better performance with this oil than they demonstrated with prewar oil when they were not kept at peak mechanical perfection.

Steps advised to get the most out of the oil allotment are: (1) Consult the oil burner manufacturer's representative on adjustments that may be needed to adapt the burner to the heavier oil; (2) have necessary adjustments made by an expert oil burner man; (3) make sure that filters or strainers are adequate for the type of fuel available; (4) keep nozzles and other parts of the combustion system clean; (5) have the cleaning and any necessary adjustments attended to now, since shortage of qualified oil burner mechanics may make it difficult to get this work attended to as the next heating season approaches.

Three Heating Simplification Schedules Revoked by WPB

Three schedules of the plumbing and heating simplification order, L-42, covering low pressure heating boilers (schedule III), cast iron radiators (schedule VI), and radiator supply valves, thermostatic, float and boiler return traps (schedule VIII) were revoked May 1 by the WPB. Order L-42 provides for the issuance of schedules establishing simplified practices for plumbing and heating equipment in order to save critical materials and manpower. The three schedules revoked were originally issued in the spring of 1942 and were designed to effect savings in steel and copper, WPB said.

Schedule III prohibited the manufacture of metal jackets, fusible plugs, and tri-cocks.

Schedule VI limited production of tubular radiators to the type commercially known as small tube radiators and permitted manufacture of these radiators only in specified sizes. Production of wall radiators was permitted only to fill orders for the Army, Navy, United States Maritime Commission, or War Shipping Administration for use on shipboard and on floating drydocks.

Schedule VIII prohibited manufacture of packless radiator supply valves with metallic bellows or diaphragm, and limited the use of nickel and copper base alloys, with certain exemptions.

WPB orders still in effect continue to restrict the use of certain materials entering into the production of equipment covered by these three schedules, WPB pointed out.

Three Limitation Orders on Valves and Fittings Withdrawn

Three WPB limitation orders affecting valves and pipe fittings were revoked effective April 28. They are L-252, which established specifications of size and material for production of valves and valve parts, subject to specific use exceptions; L-278, which limited the manufacture of steel pipe fittings to specified types, sizes and specifications; and L-288, which restricted the manufacture, sale, and delivery of gray cast iron, malleable iron, and brass and bronze pipe fittings to specified types, sizes and specifications. In all cases, WPB said, the parts affected by the respective orders remain subject to all other applicable regulations and orders of WPB.

P-126 Rating for Condensing Units Revoked

Abuses—particularly for the purpose of building up inventory—in the use of automatic ratings provided by order P-126 (giving preference ratings for parts and materials for the emergency maintenance and repair of industrial and commercial refrigerating and air conditioning systems) have made it necessary to revoke such ratings for the purchase of condensing units, the WPB announced April 17. Direction 1 to P-126 made the following provisions effective immediately with respect to new condensing units, new cabinets or other insulated enclosures, new low side units (such as unit coolers), and systems containing such items:

1) If a service agency (such as a repair shop or dealer in refrigeration equipment) has qualified to use P-126 ratings, such ratings under P-126 are revoked for the items named. The service agency may no longer apply them and must immediately cancel all orders bearing such ratings or inform the supplier that the order is no longer to be treated as rated.

2) If a dealer, distributor, or manufacturer has accepted orders for these items bearing P-126 ratings (under WPB regulations such orders must bear the required certification) they cannot make delivery. Furthermore, if they have extended such ratings, they must immediately cancel them or advise the supplier that such orders are no longer to be treated as rated. In addition, if the customer who has applied a P-126 rating for such items fails to cancel such ratings, they may not treat it as a valid rating if they know or have reasonable cause to believe that it should be cancelled.

3) If a manufacturer has accepted orders bearing P-126 ratings and has arranged to obtain these items from others by use of preference ratings assigned them for their authorized production schedule, they may not deliver such orders and must promptly adjust their outstanding orders for such items to the extent necessary to avoid having an inventory in excess of the inventory restrictions in section 944.14 (b) of priorities regulation 1.

4) A service agency that has received customers' ratings for these items may extend them to obtain such equipment or to replace inventory of these items delivered under customers' rated orders within the 90 day period permitted by paragraph (h) (1) of priority regulation 3 for extensions to replace inventory.

Such customers' ratings may originate from controlled materials plan regulation 5 and 5A for an installation permitted under paragraph (d) of order L-38 or from ratings assigned on forms WPB-1319, WPB-617, or GA-1450. Such extension of rating will be a rerating of an order already placed for a like quantity.

This direction does not affect the use of P-126 ratings in the procurement of repair parts for emergency maintenance and repair, such as controls, expansion valves, dehydrators, crankshafts, shaft seals, and other repair parts.

Those persons who may not use P-126 ratings for emergency maintenance and repair may file forms WPB-541 (PD-1A) or WPB-547 (PD-1X) for the procurement of repair parts.

"Freon" Controls Removed, But Air Conditioning Equipment Restrictions Still Effective

The recent release of "Freon," under amendment of order M-28, was for the sole purpose of permitting the operation of existing installed refrigeration and air conditioning systems, the WPB said April 17. Restrictions on production and distribution of air conditioning equipment have not been changed. An erroneous impression had arisen in some quarters that new air conditioning equipment also had been released and could be obtained without restriction.

All controls on the production and distribution of "Freon-12" and "Freon-22," refrigerants used in air conditioning and refrigerating systems, were removed April 28 when WPB ordered revocation of conservation orders M-28 and M-28a.

Production of Heating Repair Parts Classed "Essential" by WMC

Production of repair parts for heating and plumbing equipment is one of the approved interpretations issued by the WMC's essential activities committee last month. This interpretation, not specifically set forth under the group headings of the WMC's previous list of activities considered "essential" to the war effort, is now shown in "Group 15. Production of Industrial and Agricultural Equipment."

Five Amendments to Oil Ration Order Are Issued

Following is information on five new amendments to the OPA's fuel oil rationing order Rev. RO 11:

Amendment 52, effective April 11

PREVIOUS REGULATIONS

1. An additional ration to avoid hardship may be issued for heat or heat and hot water but not for hot water alone.

2. One of the tests for determining eligibility for

the additional ration is that the applicant does not have sufficient ration evidences and fuel oil on hand to meet his minimum requirements for the purpose for the remaining period of his ration.

CHANGES AND REASON FOR CHANGES

1. To authorize the issuance of an additional ration for hot water (as well as for heat or heat and hot water) to avoid hardship.

2. To exclude ration evidences (or ration credits) issued for the 1945-46 heating year and fuel oil obtained in exchange for such evidences from the calculation of fuel oil, ration evidences or ration credits on hand with which to meet the applicant's minimum needs for the balance of the 1944-45 heating year. It is desired that consumers avoid using any part of their next year's ration to meet the current year's needs.

Amendment 53, effective April 11

PREVIOUS REGULATIONS

A ration for the operation of a commercial motor vehicle may be issued only to an applicant who has a currently valid certificate of war necessity for such vehicle issued by the Office of Defense Transportation.

CHANGE AND REASON FOR CHANGE

To provide for the issuance of a ration for the operation of a commercial motor vehicle for which, under general order 21A of the Office of Defense Transportation, a certificate of war necessity is not required. Such ration is to be issued for the amount of fuel oil needed for such operation during the three month period beginning with the date on which the ration is required.

Amendment 54, effective April 17

PREVIOUS REGULATIONS

Class 3 coupons are issued as rations for domestic cooking and lighting, for heat or hot water where the amount is 300 gal or less, and for miscellaneous uses where the consumer is not required nor wishes to be in ration banking.

CHANGE AND REASON FOR CHANGE

New definite value coupons in strip form bearing consecutive serial numbers to be issued with an identification folder have been designed to take the place of the class 3 coupon sheets. The serial numbers printed on these coupons will afford a better means for determining where they were issued, to whom and for what purpose.

This amendment also clarifies the provisions of section 1394.5364 (a) (2) relating to rations for hot water furnished to residential premises other than a private dwelling by means of separate water heating equipment. That section was intended to provide rations for this purpose where the hot water is to be used in a single flat or apartment.

Amendment 55, effective April 9

PREVIOUS REGULATIONS

A ration for the nonoccupational use of a boat is issued for a three month period and may not exceed 125 gal.

CHANGE AND REASON FOR CHANGE

To permit the issuance of a ration to enable a person who has acquired a boat within the continental United States from the Navy, Coast Guard or Maritime Commission to move the boat from the place of delivery directly to the place within the continental United States where he desires it to be kept.

Amendment 56, effective May 5

This amendment provides for the renewal of rations for heat, hot water, or both, for the ensuing heating year, September 1, 1945, through August 31, 1946. The renewed rations will be issued generally in class 4B, 5B or 6B coupon sheets. Application for the ration will be made on OPA form R-1167 (Revised).

Following last year's precedent, rations for heat, hot water, or both, will be issued before the commencement of the new heating year so as to permit the movement of fuel oil into consumers' storage facilities during the summer and thus make room in the storage facilities of dealers and primary suppliers for the fuel oil which they must accumulate for later delivery.

Since the amount of fuel oil to be available for civilian use during the 1945-46 heating year is expected to be approximately the same as was available for the 1944-45 heating year, the renewed ration will generally be the same as the basic ration issued during the 1944-45 heating year except that the extra amount given to residual oil users will not be renewed.

A change has been made as to nonportable space heaters. The district director after receiving approval from the deputy administrator for rationing may issue an order removing the floor area limitation for such space heaters in any part of the area under his jurisdiction. In that case the ration for such space heaters will be the amount shown in table IX for the total floor area to be heated.

It is desirable that consumers depositing their newly issued coupon sheets with their dealers and suppliers know at that time the gallonage value of the coupons not yet detached from their previously deposited coupon sheets. It is, therefore, provided that the receipt which the dealer or primary supplier is required to issue to the consumer contain this information. If the information is not readily available at the time the receipt is issued, he must, within seven days thereafter, state the information in a notice given to the consumer.

The alternate signature sheet to be used when a consumer fails to sign his coupon sheet before depositing it has been revised to eliminate the date the coupon sheet was received from the board. The board will insert on the coupon sheet the date of its issuance.

The provisions for the deposit of coupon sheets have been further amended to permit the issuance of a court order directing the return of coupon sheets by a dealer or primary supplier who violates these provisions.

Since it is not desirable to permit a dealer or primary supplier to make application for rations for his customers, it is provided that he may not directly or indirectly apply for a ration as the agent of another person except in certain limited cases.

"Open for Discussion"

BACKING RINGS FOR WELDED PIPING

THE EDITOR—H. J. Petersen's analysis of the advantages and disadvantages of backing rings for use in welding high pressure piping, published on page 139 of the March HPAC, is confirmed, in general, by our experience. However, a well designed ring, such as illustrated in Fig. 5, page 140, of the article, minimizes most of the disadvantages. No upsetting of the pipe wall is required; no special equipment is required since the internal bevel may be produced by using a portable hand grinder if machining is not practicable; a close fit between pipe and ring is assured; and the cost is only slightly greater than when using a plain ring such as illustrated in Figs. 1 and 2 of the article.

This design does not overcome the objection of reduced internal cross-sectional area. Instances where, in our opinion, the area reduction imposed by the backing ring is sufficiently serious to warrant omission of a ring do occur, though infrequently. The "Westport" joint, discussed by H. N. Boetcher in the same article, seems to be the most satisfactory solution thus far proposed for those instances. It is our understanding that in making a "Westport" joint, oxyacetylene welding is used in depositing the first, or root, layer of weld metal, and arc welding is used thereafter. It appears that the success with this joint results from the more precise control of the heat input to the thin ends, by oxyacetylene welding, than is possible with arc welding, rather than from any unique joint design.

An entirely different approach to the problem is the suggestion of using a backing material which is sufficiently refractory to provide the desired backing during welding, and sufficiently soluble in water to be washed out of the line subsequent to welding. So far as I know, this proposal originated in the United States Naval Engineering Experiment Station, and a considerable amount of experimental work has been carried on there.—D. H. COREY, The Detroit Edison Co.

HOW SHOULD WE CONTROL SCHOOLROOM TEMPERATURE?

THE EDITOR—I have on occasion voiced my opinion that there seems to be danger of too many appliances in a plant rather than too few. This comment pertains more to the larger industrial installations than it does to the smaller plants such as may be found in laundries or garages, where the extremes of minimum necessities generally prevail.

When an American goes for anything he goes all the way. When bitten by the golf bug he soon assembles an assortment of working tools for every emergency — nine irons, four woods, a bag that is little short of a steamer trunk, and an array of clothes for which he received inspiration from the fashion plates. Then he goes out and struggles to break 100. After a time, if he is the usual Sunday golfer, and especially if he has to do his own caddying, he will discard one club after another and soon will be scoring 90 or better with a total of five clubs in his bag. He has streamlined his equipment to the bare necessities and finds that, except for occasions that seldom arise, he has all that he needs and does as well as when he was carrying around 30 pounds of assorted, specially designed hardware; he has arrived at the happy median of just right, where he has neither too much nor too little.

The promotion of victory gardens as a patriotic measure took thousands of people from their chairs, pipes, and evening papers out to the vacant lots where they cultivated a spot of clay or sand. If they were amateurs at it, as most of them were, they immersed themselves in beautifully colored and illustrated seed and plant catalogs in early spring, purchased special gardening clothes and special garden tools, and wound up with more equipment to take care of a garden bed 10 by 20 ft than used by the professional gardener who makes his living from several acres of flowers and vegetables. They paid probably twice as much for the equipment for gardening than they would have had to pay the truck gardener for everything they raised. This over-equipping for the job came from inexperience and the enthusiasm aroused by effective promotion. In their case, much that was gained was credited to health and pleasure, so there was no loss.

Most cases of over-equipping for the job can be traced to over-selling by manufacturers, distributors, and service companies. These organizations have, in many cases, done an excellent job of engineering from which the consulting engineer and the owner have gained much good information and advice, but there are examples of overselling that are not in the long run to the advantage of either the manufacturer of the device or the owners and operators of the plants. It is always difficult to strike the proper medium between what is desired and the bare necessities of what is needed, and it is still more difficult to get out of the rut of custom and precedent.

Automatic regulation and control has been one of the industrial developments of the past decade that has moved very rapidly, and since the war automatic controls—literally by the hundred — have been devised for our armed forces. Industry, too, has found so much need for exact control of different operations that modern production could scarcely function without it. The need there is very real.

When we move into the field of automatic control of conditions for space intended for human occupancy there is not the need for the same degree of refinement that there is in many industrial applications, for the human system is itself equipped with an excellent regulatory system that sets up adjustments to changes in the environment. With regard to temperature and relative humidity, the two most commonly controlled environmental factors in space conditioning, it has been customary to specify controls that will maintain temperature within 2 deg of a predetermined level and a relative humidity within 5 per cent. However, the healthy human system can adapt itself to temperature changes in excess of 2 deg and relative humidities may vary from 20 to 50 per cent of saturation without the individual being aware of the change.

Use of Entire Building As Unit of Control

It may be that types of temperature regulation in schoolrooms, for example, simpler than the exact controls now so common, might provide all of the control essential for schoolroom health and comfort. Following precedent and custom, practically all school buildings of modern design and construction have for years provided complete automatic regulation for every separate room. Some object to the general practice of installing temperature control systems in schools that provide an automatic thermostat and separate control for every room—the objection being principally that such a system is expensive to install, expensive to maintain, and permits tampering by teachers and pupils. The alternative suggested is either a return to hand control, or a simplified type of control that uses either the entire building or a floor or a large section of the building, instead of the individual room, as the unit for control. In one of these schemes, where heating is accomplished by direct steam radiation, an orifice or other permanent device is fixed in the steam supply to the room, the size of the orifice being determined by experiment to allow enough steam to enter for heating the room under the coldest weather condition. Each room thus has its orifice selected through an original test. Steam to the mains supplying the building or any part of the building is regulated by an outside thermostat that increases or decreases the total steam supply to the building or zone, dependent upon outside weather conditions. This arrangement removes all thermostats from the rooms and all possibility of tampering by the occupants of the rooms. It does not, however, provide as complete nor as accurate control as does the automatic room thermostat that deals with each room as a unit. It will not make complete provision for changes in solar heat, action of varying winds, or changes in room occupancy, and will permit a certain amount of overheating of some rooms.

WHEN ENGINEERS gather to hear a paper or talk, there comes a time when the meeting is thrown "open for discussion." We follow this custom in these columns, which provide an opportunity for readers to comment and discuss articles published in HPAC and other topics of interest to heating, piping, and air conditioning engineers and contractors. The editors will welcome your remarks. Address Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.

Controls are designed and applied in countless combinations that provide any degree of regulation desired, from zero to the maximum, that makes a plant almost robot-operated. Engineers can select from the equipment offered devices and adaptations that will assure any performance desired. There must first be a decision on just how much regulation there should be.

Overheating Wastes Fuel

Since the war began we have stressed fuel economies a great deal and have shown that in the climate of Chicago, for example, for every degree the average indoor temperature of a building is maintained throughout the heating season above 70 deg there is an increase of 3 per cent in the heating steam requirements of the building. This has brought about a quite general tightening up of building structures to provide barriers against heat flow from the inside to the outside, and has brought about an interest in keeping temperatures from rising above minimum comfort levels. An individual control for each room that prevents any overheating will make it possible to save more fuel than could be saved by any building control and should provide a higher standard of comfort.

The results obtained by the more complex and complete automatic control by rooms should be compared with those obtained using the simpler control, in which the building or the zone is the unit, to determine whether or not the improved results justify the additional cost of the equipment. In regulation of temperatures of classrooms we should strive to arrive at that median of just right—neither too much nor too little.—JOHN HOWATT, business manager and chief engineer, Chicago Board of Education. Member of HPAC's board of consulting and contributing editors.

IT'S NOT THE HEAT PUMP, PROFESSOR TUCKER!

THE EDITOR—The problem of the heat pump,* or reverse cycle refrigeration, is not the lack of soundness of the fundamental principle involved, but the lack of a really comprehensive understanding of the heat pump and the potential advantages it affords. There may be quite a few people who understand the heat pump, but there are only a small handful who demonstrate that they are aware of its advantages. There are too many of us in the field of heat transfer who are prone to follow, rather than lead; who adapt and improvise, rather than conceive new and practical uses.

If we are to give the principle of the heat pump a fair chance to succeed in providing year 'round comfort in the near future, we must first abandon the use of equipment that is designed to accomplish other functions. The writer in recent months has had occasion to study the possible application of the heat pump to the function of providing year 'round comfort in the small, modestly priced, postwar home. It didn't take much examination of existing practice and a study of adaptations of existing equipment to realize that considerable ingenuity to apply the principle of the heat pump to this particular purpose is necessary.

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*See What's Holding Back the Heat Pump?, by J. Mack Tucker, in the March HPAC.

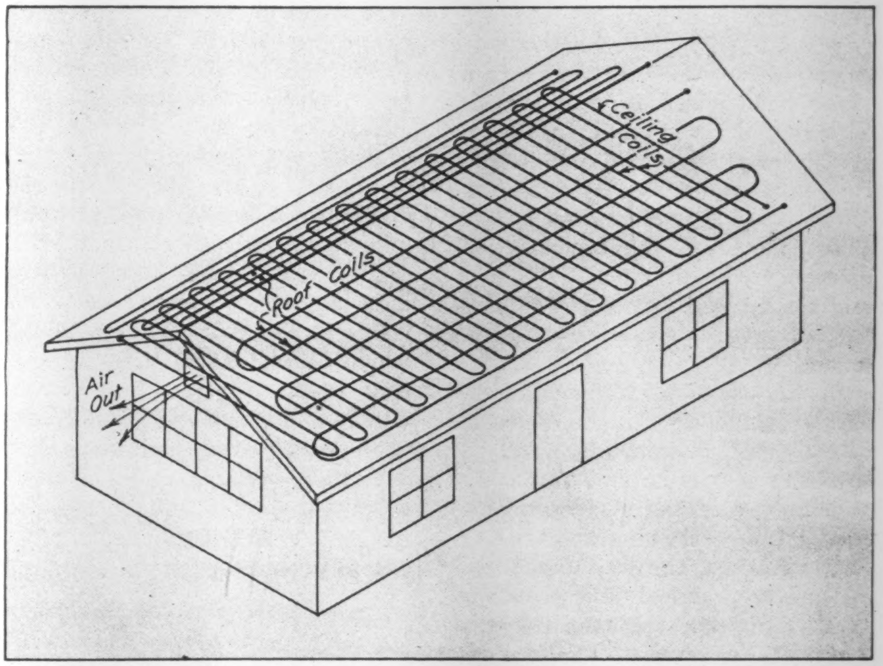
Build Around the Comfort Needs

We still build homes in much the conventional manner and then, as sort of an afterthought, attempt to append the comfort-producing equipment to the job. The end result is expense, inefficiency, and dissatisfaction. The comfort-producing equipment of tomorrow's home is as important a part of the home as any of the other materials or equipment that go in to comprise the structure. A national organization in the building field made a survey not so long ago of postwar requirements in housing, and much to their great alarm, found that comfort as expressed by the term "air conditioning" was the most important factor likely to influence the purchase of a new home, and that if the house weren't air conditioned, there wasn't much likelihood of the prospect wanting it. As a result, a national campaign was inaugurated to tell people to expect, not air conditioned homes, but pretty much the same old stuff that they had prior to the war—except for a few fancy gadgets.

The writer has always thought that a house isn't worth a tinker's damn unless you are comfortable in it regardless of the season of the year, and his experiments in housing have endeavored, maybe improperly, to build a house around its comfort needs.

In reviewing the possible use of the heat pump, it seemed to us rather obvious that even with so-called mass production techniques, a packaged unit employing the heat pump principle, water cooled, and with water as a source of winter heat, and with an elaborate duct system for the distribution of conditioned air, was not in the cards for the modestly priced home. A number of manufacturers do have rather cleverly devised packaged units of this character and they will find a market for the rather limited number of units that they will produce. To reach a modest-priced market, one has to think in terms of hundreds of thousands of houses and, therefore, hundreds of thousands of mass produced heating systems, all of a definite size and all geared to a definite performance. The hit-or-miss application of universal equipment always ends up in compromised results.

There have been offered for public observation and study hundreds of well conceived plans of homes, and for the sake of study of the possible application of the heat pump, a simple little two bedroom, one story house with a gable roof was selected. It became obvious that if the heat pump were to be successful, at least from the standpoint of simplicity of equipment and low first cost for the complete system, much of the structural elements of the house would have to serve as the means of heat exchange.



"An all-metal roof would serve as a heat rejecting or heat absorbing surface, depending on the function to be accomplished."

With this as a premise, a little "imagineering" might then be in order. Assume that our house was well insulated and that it had insulating windows. It might be desirable to employ an all-metal ceiling over the entire area of the house and also to use either the exterior walls or the partition walls as heat exchange surface (and, therefore, they likewise might be of metal sheets). An all-metal roof supported by a metal truss would serve as a heat rejecting or heat absorbing surface, depending on the function to be accomplished. Mounted in the attic space would be one of the newer types of high speed, hermetic, vibration-free compressors.

Roof Would Serve as Evaporator

During the winter cycle, the roof would serve as the evaporator for the refrigerant. A none too thorough study has indicated that a tremendous amount of solar energy impinges on the roof which can be picked up by the evaporating refrigerant. Outside air, of course, is a substantial source of heat—and air blowing over the roof as well as air being circulated through the attic space by a fan would afford a substantial source of energy. On the few occasions when the roof is covered with snow and the air is too low in temperature to provide all of the required energy, the refrigerant gas from the roof would pass through a shell and tube heat exchanger through which hot "Dowtherm" from a small electrically heated reservoir would provide the added energy required. The "Dowtherm" reservoir would be heated with offpeak electrical energy.

The heavily insulated metal ceiling would serve as the refrigerant condenser, radiating heat by the panel heating method to the space to be maintained at the required air temperature and mean radiant temperature.

Summer Comfort by Panel Cooling

To provide summer comfort, the system is simply reversed and the roof heat exchanger becomes the condenser. For many hours of the period when cooling is required, air over the roof and under it through the attic space would be adequate for condensing, but on very hot, sunny days, water could be flowed over the roof to augment the required condensing result.

To provide summer comfort or panel cooling, the ceiling now becomes the evaporator for the refrigerant. All of the ceiling area is employed and possibly for certain kinds of houses some wall area is required in order that the evaporator temperature will remain sufficiently high to avoid condensation on the cooling surface. As a possible counter to the condensation problem, a small silica gel dehumidifier might be employed in connection with ventilation requirements.

By the use of a little good application engineering in the selection of the right amount, kind, and location of insulation and by the ingenious use of the structural surfaces of the house as a means of heat exchange, the heat pump can become a practical and economic reality. Sheet metal is not the only material necessary to the success of such an undertaking, for the writer has experimented with copper tubing imbedded in a cement plaster which has indicated equal performance. Such practice, for example, would permit stuccoed exterior walls with copper tubing in them to serve as the condensing and evaporating surface. Such an undertaking requires ingenuity in numerous directions—such as the proper headering of coils to get successful performance with the refrigerant, and a valving arrangement that will permit easy transfer of such a surface from evaporating to condensing. It also requires experience in operating with refrigerants at temperatures and pressures higher than in conventional practice, and possibly the development of new refrigerants.

On the summer cycle, if sufficient evaporating surface is used at a high enough temperature, condensation can be avoided. This will make it possible to maintain a sufficiently satisfactory design summer mean radiant temperature without the need of dehumidification as a necessary function to such comfort. As is well known in conventional air conditioning practice, the need for dehumidification accounts for the greatest percentage of energy requirement. If, with having a successful mean radiant temperature, heat exchange by sensible means only is possible, there is a potential saving in required energy to do the job.

It seems to the writer that some of the shipbuilders, aircraft manufacturers, and others who contemplate volume production of shop-manufactured houses could well consider the simplicity and utility of the heat pump. They should also find that a proper design would afford real operating economies to the purchaser. The electric utilities have a great stake in the potentialities of the heat pump and it would be well worth their while to back extensive research and investigation in the application of the heat pump to the small home field. —CARL F. BOESTER.

FLYING WEATHER BY PSYCHROMETER

An accurate aircraft psychrometer, for measuring temperature and humidity while an airplane is in flight, has been developed by the meteorological branch of Camp Evans signal laboratory. This instrument is now in active use on B-17, B-24, and B-25 bombers in many zones of operation as calibration equipment for aerograph instruments. The latter instrument obtains continuous records of the meteorological conditions of the atmosphere.

Intensive experimentation was needed to bring the aircraft psychrometer to a degree of accuracy that made it practical. Mercury thermometers having their tubes bent at right angles are mounted so that the calibrated portion of the tube may be read inside the fuselage of the plane, but the bulb of the thermometer extends outside into a streamlined duct.

Used mostly on weather reconnaissance planes, the psychrometer, in combination with aerograph equipment, has made it possible to gather vital weather data over enemy territory so that accurate forecasts of weather to be expected over a military target may be made preliminary to take-off on combat missions. This information, supplementing weather data gathered by standard procedures, has resulted in far more extensive weather briefing, for such missions, than heretofore possible.

SIMPLIFIED SOLDER JOINT FITTINGS PROPOSED

A proposed simplified practice recommendation for cast brass, solder joint fittings has been submitted to producers, distributors, and users, for acceptance and comment, according to an announcement by the division of simplified practice of the National Bureau of Standards, Washington 25, D. C.

The proposal contemplates the establishment of a voluntary simplified list of cast brass, solder joint fittings representing the best thought of the industry, its distributors, and customers as to what constitutes desirable practice for the present and the postwar days to come. Sketches illustrate the 37 types of fittings, various sizes of which are included in the proposed list.

VALVE MAKERS NAME HOLTON

W. B. Holton, Jr., president of the Walworth Co., was elected president of the Valve Manufacturers Association at a recent meeting of the association.

Since March 9, 1943, Mr. Holton has been production consultant and head of the valve and fittings industry for the WPB as a dollar a year man. His resignation from this position became effective February 1.

ICI ELECTS TWO DIRECTORS

Election of two new directors to fill two vacancies on the governing board of the Indoor Climate Institute was announced last month by Paul B. Zimmerman, ICI president. They are C. A. Olsen, president of the C. A. Olsen Mfg. Co. and president of the Henry Furnace Co., and Bruce T. Cunningham, sales executive of Research Products Corp.

Heating, Piping & Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

Mine Ventilation and Its Relation to Health and Safety[†]

By D. Harrington[*], Washington, D. C.

SUMMARY — The author reviews the need for adequate ventilation and its value in all types of mining operations. Sources of health hazards and means of using ventilation to improve conditions are carefully discussed.

Safe practices are advocated and recommendations for adequate ventilation systems are outlined.

VENTILATION is the keystone of safety in underground *coal* mining and of health in underground *metal* mining. Effective ventilation of underground workings requires the establishment and maintenance of such control of air that underground employees may work in safety, with a maximum comfort and efficiency and without impairment of health; that the mine openings be made subject to such flow of air as to remove from the workings at ordinary times harmful gases and dusts; and that at times of emergency, such as fire or explosion, as much or as little air as desired may be circulated to any or all parts of the mine.

Control of air flow is absolutely necessary and is obtainable only by installing mechanically operated fans and other ventilating devices, such as doors, overcasts, regulators, etc. From the outset, every underground mine should be equipped with a fan. There are few, if any, coal or metal mines where natural ventilation even in ordinary times supplies safe or healthful conditions for underground workers and when a fire or explosion occurs, mines that depend on natural ventilation are virtually helpless and certainly are dangerous to those unfortunates forced to be in them.

Although ventilation and its control have almost always been deemed integral parts of coal mining, little attention has been paid to air circulation in metal mines until some untoward condition or accident has made it necessary, yet the need of efficient circulation of air is at least as necessary in metal mines as in coal mines. The dangerous, explosive gas, methane, as well as fumes from explosives, and in some places other gases, such as CO_2 or hydrogen sulphide or nitrogen, must be removed from coal mines. In metal mines there is much greater necessity of removing fumes from explosives because much larger unit quantities are used and frequently, CO_2, nitrogen, occasionally methane and other gases, must be removed from strata. Circulating air currents are urgently needed to reduce the excessively high humidity and temperatures found frequently in metal mines but more seldom in coal mines. The immense quantities of minutely fine particles of rock dust that float in the stagnant air of metal mines and are very largely responsible for miners' consumption and other diseases, so prevalent among metal miners in many regions, could be removed very largely by adequate ventilation. The general conception prevails that coal miners have a relatively healthful occupation while many metal miners contract diseases such as lead poisoning and miners' consumption and either die early in life or are incapacitated in middle age. The difference in effect upon health is due almost wholly to the superior working conditions frequently found in coal mines—chiefly to better ventilation.

Larger metal mines are comparable in many respects to an immense office building or hotel. The various levels correspond to the floors of the building, except that in a mine they are 100 ft or more apart vertically instead of 10 or 20 ft as in a building. The drifts and crosscuts correspond to the halls and corridors and the raises, stopes, and other working faces to the offices, sleeping rooms, etc. In the mine however there are no openings to correspond to windows to the outside, and, too frequently, no openings between working places to correspond to interior doors between offices or rooms. In many cases this leaves only one opening to the working place. In general, the present practice, even in the better-ventilated metal mines, is to cause currents of air to flow along the main drifts and crosscuts with only such volumes of air going into the working places as might seep by diffusion through one opening. The workers usually are engaged in some fairly strenuous operation such as drilling, timbering, or shoveling, which tends to fill the air with fine dust (the most dangerous kind); or they may blast to bring down rock or ore and thereby liberate not only clouds of fine dust but also smoke laden with poisonous gases. Too frequently the surrounding walls are damp and at a temperature of 80 to 100 F and the stagnant air may be at a temperature of 80 to 100 F or even higher, while the relative humidity may be 90 to 100 per cent.

[†] Published by permission of the Director, Bureau of Mines, United States Department of the Interior.

[*] Chief, Health and Safety Branch, Bureau of Mines.

Presented at the 51st Annual Meeting of the American Society of Heating and Ventilating Engineers, Boston, Mass., January 1945.

Coal mines usually are required by law to have a ventilation system, but in many mines compliance with the provisions of the law is anything but complete, and as a consequence accumulations of explosive gas ignite in scores of coal mines every year and cause a heavy loss of life.

Approximately in order of their importance, the main features that affect air in metal mines are (1) air movement, (2) temperature, (3) relative humidity, (4) gases, and (5) dusts. In coal mines the order of importance would probably be (1) air movement, (2) gases, (3) dusts, (4) relative humidity, and (5) temperature.

The matter of movement of air from the surface, through the working faces or places, and then back to the surface is by all means the most important consideration in effecting adequate ventilation of mines, and in protecting the health and promoting the efficiency of the underground workers. If adequate quantities of pure air are directed to and through the places where men work, most of the requirements of health and many of the demands of safety and efficiency will be well-served.

The temperature of underground air is affected by temperature of outside air in varying degrees, depending upon the depth and extent of the workings, upon air velocities, and other considerations. The temperature of mine air is very definitely affected by underground rock and water temperatures, by the quantity of air flowing, by oxidation (or decay) of timbers, coal, and ores, and by mine fires. It is also affected to some extent by friction, moving of ground, firing of shots, and heat from lights and from breathing of animals. Heated air obtained from other mines and from contact with electric motors and other machinery may seriously affect the local temperature of air of underground workings.

Relative humidity of underground air is affected to some extent by humidity of surface air, but much more vitally by moisture of surfaces of underground workings and especially by water dripping through the air. Quantity, temperature, and velocity of air flowing also ultimately affect the humidity of underground air and influence the effect of the humidity on the workers. Water used in drilling, wetting ore or coal or mine surfaces, or in sprays, water blasts, etc., also contributes to mine-air humidity.

Gases in mine air may come from surface air, from breathing of men and animals, from lights used, from firing of explosives, from compressed air used with machines or in blowing, from operation of various kinds of machinery including fans, and from various coal, rock, or other strata encountered, as well as from active or incipient mine fires.

Dusts found in metal-mine air are derived largely from drilling, blasting, shoveling, from mucking, tramming or dumping rock or ore or from timbering, and hauling. Probably well over 50 per cent of all metal mines have siliceous material in ore or containing walls and hence have siliceous dusts, which, as far as is known, are the most dangerous of all of the ordinary earth dusts, especially when taken into the lungs in large quantities in the extremely finely divided form thrown into the air by drilling, blasting, and mucking. Certain siliceous dusts seem to have far less injurious effects than others of essentially the same composition. Dusts of other than siliceous character, while not considered to be so definitely and immediately dangerous, are nevertheless likely to be harmful ultimately, especially if present in the air in very finely divided particles and in large quantities. The dusts of certain soluble lead ores affect workers through skin absorption as well as through breathing. Dust in coal mines is caused by processes somewhat similar to those in metal mining, in addition to those created by undercutting, overcutting, and shearing, and much dust is now being created by various kinds of mechanical loading devices. Coal dust may be very explosive under some conditions, and in addition is a definite health hazard especially when present in the air in large quantities during a considerable part of the time spent underground. Moreover, its presence in large quantities in air very greatly reduces visibility and this in turn adds greatly to the danger of accidents.

Mine ventilation was discussed much more 15 to 20 years ago than it is now, yet today there are tendencies in connection with mine ventilation which indicate that the lessons learned by bitter experience in the past either have been forgotten or have not been brought to the attention of the present generation. Possibly the mining men of today consider that conditions have changed so much that experiences of the past cannot be repeated. At any rate, it seems desirable to restate some of the principles of mine ventilation that were understood more or less in the past and to call attention to some dangers in connection with present-day trends or practices.

One of the more seriously dangerous trends in mine ventilation is the placing of the main fan underground in coal mines—a decidedly dangerous practice and one very likely to cause numerous disasters if it becomes widespread. The placing of the main fan underground in metal mines is somewhat hazardous but is by no means so dangerous as in coal mines. In many recent main-fan installations on the surface of coal mines the fan has been placed in a direct line with the mine opening—a hazard, since the fan is likely to be destroyed or be damaged seriously in case of an explosion. The main fan for a coal mine should certainly be placed on the surface in a fireproof housing and should be offset at least 25 ft from the line of the mine opening, while explosion doors that can be opened easily should be provided to relieve pressure in case of an explosion. In many metal mines (partly to reduce air dustiness and partly to prevent formation of ice in working shafts) ventilation systems are installed with the working shaft on return air. This is extremely hazardous where the workers must be transported through the shaft, because in case of fire the shaft is very likely to be filled with poisonous gases and the men in the mine may be trapped or killed. Safety demands that the man-hoisting shaft be safeguarded by being in either intake or downcast air with provision for preheating it in winter. Preferably, the man-hoisting shaft should be essentially neutral as to air flow, with only enough fresh air to keep it free of gases or undue cold or humidity, and other shafts or openings should provide fresh air and remove vitiated air.

Most mine-ventilation installations are intended to achieve only some of these foregoing objectives and consequently fail to give protection to mine workers or mines. In numerous cases a slipshod or poorly planned and operated ventilating system is a menace to either safety or health, or both. However, many of the worst disasters in both coal and metal mines have been due to glaring defects in elaborate and relatively costly mine-ventilation systems and installations or in their careless or ill-considered operation.

General Conclusions

Some general conclusions are enumerated as follows:

1. In mining, it appears that ventilation, fire protection and prevention, health, safety, and efficiency are very closely interrelated, and, consequently, conditions, installations, and equipment affecting any one of them may have a vital effect on one or all of the others, detrimentally or otherwise.

2. There is at least as much reason for providing adequate ventilation for most metal mines as for providing ventilation for coal mines, though metal mine operators rarely provide ventilation until forced to do so by some untoward conditions or occurrence. Coal mines, on the other hand, are usually ventilated to some extent from the beginning. The increased attention to occupational disease, especially when caused by dust, has provided an incentive for greatly added attention to ventilation by the larger metal-mining companies in the past few years.

3. Every coal or metal mine should have a mechanically driven fan or fans preferably placed on the surface in a fireproof housing and capable of reversing the direction of flow of air currents with a minimum of delay. Metal as well as coal mines should provide fan ventilation from the start of opening to avoid dangers from explosives or other fumes, dusts, etc., and to provide fresh air to workers. Mines that rely on natural ventilation are likely to have periods when air circulation is sluggish, ceases utterly, or reverses in direction; and in case of fire socalled naturally ventilated mines are almost invariably at a decided disadvantage because of inability to control the direction of air flow.

4. Ventilation should be under definite, constant supervision, preferably of one person, who should report to the highest officials. Each mine should be ventilated wholly within itself as interventilation of mines is likely to be dangerous, inefficient, and generally unsatisfactory, even though it may have some minor or transitory advantages. Any mine employing more than 200 persons should have at least one person working exclusively on ventilation if health, safety, and efficiency are to be protected adequately.

5. Ventilation is probably the most effective means of obtaining dust-control, although it ranks second to wet methods under some conditions. Where ventilation can be applied effectively, dust can be removed from the air, or its concentration can be kept so diluted as to render it almost harmless to workers. Ventilation can minimize dust hazards of almost all kinds, including spontaneous combustion, but it may enhance the hazards of dust explosibility in some instances. Ordinarily ventilation should be induced by exhaust methods, but sometimes forced or blowing systems are the more effective, particularly in underground work in places having high-temperature air conditions. It is usually difficult to attain really effective ventilation in such work as tunneling and metal mining because ordinarily openings are usually driven singly instead of in pairs, as in coal mines, where fresh air flows in one opening and return or contaminated air flows out through the other. Conditions caused by dust may force the use of parallel openings in many future tunneling and metal-mining operations. Notwithstanding the violent objection this suggestion will raise, there are good reasons for believing that in many cases there would be definite monetary savings if the parallel-opening system—with its numerous ventilation, health, drainage, and other advantages—were used instead of the present one-opening system, which has numerous disadvantages and hazards and only the one advantage that its use has been customary.

6. Dry drilling is unquestionably the dustiest work in mining, tunneling, or quarrying, and it continues to be used far too much in the United States not only in small mines but in some of the larger ones working in rock or ore having so-called harmless dust. If dry drilling is allowed at all, it should be done only with auger twist drills or with the simultaneous use of dust traps where the use of such equipment is feasible. Wet drilling, as practiced in the United States with water forced or drawn through the drill steel by means of compressed air, for several years has been under fire as producing relatively large quantities of dust, even though the material floating in the air usually is wet. Some of this criticism is undeserved, but some is legitimate. The trouble is due largely to the fact that the holes are collared or started dry and, in some cases at least, are drilled dry for several inches after starting, and the dust created by this dry starting impregnates the usually stagnant air of the ordinary underground-tunnel or metal-mine working place for much, if not most, of the working shift. In some cases the driller limits drastically the amount of water sent through the drill steel and, while drilling is nominally wet, the actual practice closely approximates dry drilling with compressed air flowing through the drill steel and forcing out of the drill hole and into the air of the working place undue quantities of water-entrained dust particles. In some cases when the drill is out of repair, the drilling allows far too much compressed air to flow through the drill steel. When present types of wet drills are used properly, the dust from drilling can be kept within reasonable limits and this practice is actually being followed by numerous progressive and conscientious mining

and tunneling companies at the present time. Some companies in the United States and Canada are experimenting with rock drills that do not allow compressed air to go through the drill steel but require the water to be forced through the steel by its own pressure; such drills are said to produce less dust than the usual types in which water is sent through the steel by compressed air; but the newer type of drill has been little used in the United States. However, air dustiness can be kept well within safe limits if (*a*) modern types of wet drills are operated with care and judgment and plenty of clean, dirt-free water is used in collaring and if the drills are kept in good repair; (*b*) if the proportions of water and compressed air flowing through the drill steel are regulated adequately; (*c*) if the exhaust from the drill is prevented from impinging on nearby dusty surfaces of muck piles, floors, walls, or timbers, thereby throwing dust into the air; and if (*d*) insofar as feasible, the drilling of upper holes is reduced to a minimum, as upper holes, whether drilled dry or wet, are relatively heavy producers of dust in the air of working places.

7. Although there are regulations in most of the States to prevent dust formation in drilling, these regulations are not always observed, especially in small mines or prospects. Although miners recognize the dangers from dust, they often prefer to take the risk rather than endure the slight discomfort or extra trouble of using precautionary methods or devices essential in wet drilling procedure. Mine and State officials seem to feel that unless the miners willingly aid in protecting themselves, the management should not be required to force them to protect their own health and, incidentally, that of their families. Dust-prevention devices of proved success, such as modern self-rotating wet stopers, should entirely supplant dry drills, and their use should be enforced upon both miners and operators in metal mines, large and small, irrespective of the silica content of the rock being drilled. There is absolutely no valid excuse for dry drilling in modern metal mining, and to date no workable device is available for removing dust formed in dry drilling in underground mines.

8. Next to dry drilling, blasting causes the greatest quantity of finely divided dust to be thrown into working places through bringing down rock in mining, quarrying, and tunneling. In addition to throwing violently into the surrounding air immense quantities of finely divided dust, blasting, with the heavy charges of explosive required in many mining and tunneling operations, also impregnates the surrounding air as well as the muck piles with considerable quantities of poisonous gases, such as carbon monoxide, oxides of nitrogen, and, in some kinds of rock, with hydrogen sulphide and other dangerous sulphurous fumes. Practically all of these occur in such quantities and percentages under some circumstances as to asphyxiate or cause serious illness in persons who may breathe them. Many persons who have studied the incidence of dust disease believe that the breathing of even small quantities or percentages of extraneous or harmful gases, such as carbon monoxide, oxides of nitrogen, hydrogen sulphide, etc., inflames or otherwise adversely affects the respiratory organs, especially the lungs, and makes them much more easily and readily susceptible to harm from the breathing of dust particles.

9. Blasting practice must be modified and reformed if employers are to avoid heavy penalties in compensation and other charges due to legislation on occupational diseases (one being dust disease) in the various States. If at all feasible, blasting should be done at the end of the working shift or on an off shift, and the dust- and gas-laden air should be removed or thoroughly diluted before men return to work. Ventilation is an essential agency in cleansing the air where blasting has been done; but, in addition to being ventilated, the place should be thoroughly wetted (walls, floor, roof or top, timbers, etc.) before blasting is done, and in metal mines a water blast should be used during and after the blasting. The region should be wetted thoroughly upon return to the face after blasting, and the muck pile should be kept well wetted at all times while it is loaded out, as the water not only lays the dust but also either absorbs or otherwise aids in diluting or eliminating harmful or poisonous gases which follow blasting and which usually cling to the blasted material. In general, the larger the quantity of explosives used and the more finely divided the blasted material happens to be, the more heavily will the air be impregnated with dust and smoke and the greater will be the quantity of poisonous gases left at the place. Methods used should therefore be such as will tend to reduce the quantity of explosives used and the gases and dust produced. In this connection, it will be found that the use of stemming or of some types of blasting plugs now available will confine the explosives more definitely, will increase their efficiency and reduce the quantity of explosives necessary, will reduce the volume of poisonous gas produced, and possibly may decrease the violence of the blast and reduce its tendency to raise and disseminate dust. It would be well for users of explosives to investigate types of explosives known to emit minimum quantities of harmful gases on detonation and to use them. Discontinuance of the use of fuse and substitution of electric blasting would aid in reducing the amount of poisonous gases caused by blasting. Explosives that have been held in storage too long or have been stored under unfavorable conditions as to moisture, temperature, etc., are likely to give off maximum quantities of harmful gases. The utmost care should, therefore, be taken in the storing of explosives to see that they are stored under favorable temperature and humidity conditions and are not held too long before being used.

10. Although finely divided dust in mines is probably the chief cause of miners' consumption, it is now recognized that other factors, such as high temperatures and humidities, harmful gases, and lack of air movement, may have almost equal influence. All of these factors can be controlled readily by ventilation. It appears that with a dry-bulb temperature below 75 F, mine working places may be comparatively comfortable, irrespective of the air movement or relative humidity. However, the presence of air depleted of oxygen (say below 18 per cent) or impregnated with even small proportions of gases, such as CO_2, CO, or oxides of nitrogen, any or all of which may be produced in blasting, may produce uncomfortable or unsafe conditions.

11. With a dry-bulb air temperature above 75 F, comfort and maximum working efficiency can be obtained only when the air is moving, especially if the air has high relative humidity. The exact velocity necessary is a variable, depending largely upon the temperature and humidity. Saturated atmospheres relatively free of harmful gases or dusts, up to nearly blood temperature, may be made endurable and even tolerably comfortable by providing sufficient velocity or movement.

12. In still air in metal mines with a temperature of about 85 F and 90 to 100 per cent relative humidity there is likely to be little or no harmful effect on persons completely at rest; but, with even moderate work, body temperature is likely to rise above 100 F, blood pressure may fall perceptibly, and pulse beat may rise materially. In still air, with temperatures of 90 to 100 F and with more than 90 per cent relative humidity, even when the individual is practically at rest, body temperature rises quickly (in cases reaching over 102 F), blood pressure is likely to fall rapidly, pulse beat may increase abnormally and be very sensitive to even slight exercise, and perspiration may be very profuse. Dizziness, physical weakness, mental sluggishness, and headaches are likely to be experienced in time. When even light work is attempted, these symptoms are likely to be augmented greatly.

13. Relative humidity, even up to the saturation point, does not appear to be harmful to health, comfort, or

efficiency until the temperature runs above 75 F, and if sufficient air movement is supplied, high relative humidity is not particularly harmful until the temperature is well over 90 F.

14. With the exception of blind-end unventilated working faces, mine air in general is not particularly deficient in quality. However, the air at blind-end unventilated faces of drifts, crosscuts, raises, winzes, and stopes in metal mines is likely to be deficient in oxygen and high in nitrogen or CO_2 and possibly in CO, oxides of nitrogens, or other impurities. There are on record many cases of asphyxiation from these gases in metal mines. Similarly, dead-end unventilated places to the dip, to the rise, or on the level in coal mines may become depleted of oxygen through absorption by the coal or timbers or through intrusion of extraneous gases, nitrogen, carbon dioxide, methane, etc. Places under seal in either coal or non-coal mines are almost sure, in time, to have the oxygen content considerably depleted and the carbon dioxide or nitrogen (or both) content increased.

15. In stagnant air comparatively small quantities of impurities, such as 0.30 per cent or more of CO_2, 0.02 per cent or more of CO, or oxygen slightly below 20 per cent, cause headache, dullness, etc., and this is particularly true when the temperature is above 80 F. However, these small quantities of impurities are not so likely to be noticeable when there is perceptible movement of the air.

16. Frequently blind-end actively worked faces in mines (and more particularly in metal mines) have air so depleted of oxygen that a candle will not burn and carbide or other lamps must be used; hence, oxygen content is below 16 per cent and CO_2 may reach several per cent. Occasionally entire mines are found with this condition, which are regarded as satisfactory by many mine managers. Men working in an atmosphere that will not support the combustion of a candle cannot work with maximum efficiency, and ultimately their health will probably be affected. Safety is certainly endangered by such conditions, inasmuch as human life cannot be sustained when the oxygen content of the air is less than 6 per cent.

17. Mines with cool working places that allow men to work at top speed, especially when contracting, are likely to be extremely dangerous to the health of workers unless provision is made to remove explosives fumes and other gases and fine dusts from working places with ventilating currents. Mines with high temperature (above 75 F) and high humidity (above 85 per cent) are likely to reduce efficiency of workers 25 to as much as 75 per cent, and workers are likely to become unhealthy eventually unless moving currents of air are supplied to working places. Unhealthfulness and inefficiency are hastened and intensified if fine dust, especially siliceous dust, is present, and if blasting is done, especially when men are in the mine.

18. Many accidents in mines are due to deficient ventilation. Failure to remove smoke and fumes from explosives prevents efficient inspection of working places to make them safe. In addition, many men have been asphyxiated in explosives fumes. In hot, humid, stagnant air men are likely to be affected by dizziness or by lack of ability to think clearly or quickly, or they may faint and be killed. Also, there are numerous instances where men have been known to have dropped dead in hot places, and scores of underground workers have been killed upon going into unventilated places in which the oxygen content of the air has been reduced in any of several ways previously mentioned when ventilation has not been maintained.

19. When the temperature of the air exceeds 75 F, mere movement of the air at working places is more important than anything else in giving adequate ventilation, provided such air is reasonably free of noxious gases and dusts.

20. Flowing air in underground passages rapidly assumes the temperature of the surrounding rock. The rate of change is variable and frequently is as high as or higher than 1 deg F for every 100 ft of air travel. The temperature of still air underground rarely varies more than a few degrees from that of the surrounding rock or water. Rock temperature generally increases with depth, the rate of increase ranging from 1 deg F or more per 100 ft of depth in certain districts of the western part of the United States to but ½ or ⅓ deg F per 100 ft of depth in other regions, both of the United States and of foreign countries. Rock temperature may vary at the same depth in different kinds of material. A copper sulphide ore with quartz gangue in a mine in the western part of the United States had rock temperature several degrees higher than a zinc sulphide ore in quartz gangue in a parallel vein about 200 ft distant, both on the same level and both practically free of water.

21. Water standing still or flowing on the floor in mines readily communicates its temperature to surrounding air. Water dripping through the air quickly brings the air practically to the temperature of the water drippers, and profuse water drippers will determine the temperature of the air almost irrespective of rock temperature. Water temperature underground is generally, but not always, the same as that of surrounding rock.

22. The dry-bulb temperature of air passing through fans frequently has increased several degrees Fahrenheit, and the relative humidity has automatically decreased. Small, electrically driven fans with galvanized-iron or canvas or other flexible tubing are being used widely to great advantage in metal mines and tunnels to carry air to dead ends. The galvanized iron has the advantage of allowing reversal of air currents to pull smoke out after blasting, then to force moving air to workers after the smoke has been removed. Moreover, it does not deteriorate as fast as canvas. In general, the flexible tubing must be used only in forcing air to the face. Its advantages are low first cost, ready installation and removal, flexibility in conforming to bends or turns, and ease of repair. Moreover, because of its ready installation and removal, the flexible tubing can be brought close to the working face at ordinary times and easily removed before blasting to prevent its destruction. Either method readily permits 500 to 5,000 cu ft or more of moving air per minute to be applied at the working face at comparatively small cost. The use of these small fan-tubing units in underground coal mines is hazardous in the extreme; and in the past two decades scores of explosions, with heavy loss of life and many fires, have been caused in coal mines through the use of fan-tubing blower systems.

23. Compressed air from the end of air hose is used extensively to remove explosives fumes from faces or to ventilate hot, stagnant, blind-end workings in metal mines. These blowers deliver about 100 cu ft of air per minute, but its temperature rarely varies much more than 2 or 3 deg from the temperature of the rock and air of the working place. Such compressed-air blowers are inefficient for removal of smoke or gases, provide comparatively little pure air, and cause very little reduction in the temperature of the surrounding air. Moreover, it costs about 100 times as much to place 1,000 cu ft of compressed air at a working place as to circulate a like amount of air by ordinary ventilation methods. Compressed air is employed only to a limited extent in ventilation in coal mines, and its used in coal mines is not only expensive and inefficient, but also definitely dangerous.

24. Air in mines is cooled by using ice or sprays of cool water, by refrigeration, by rapid coursing of air brought from the surface or carried slowly through workings with cool walls, by excluding air from hot, abandoned workings and excluding return air from currents of active workings and possibly by other procedures. Water sprays are not employed nearly as much as they should be. Ice is used to a slight extent in the United States. Refrigeration is costly and found in a very few mines, although several hot metal mines in the western part of the United States are now using refrigeration to advantage.

Rapid coursing of air currents from the surface, which can be brought about most efficiently by the establishing of definite splitting systems, is used only occasionally, though it is quick, relatively cheap, and efficient. Failure to seal abandoned places having decayed timber and hot rock or water sends much unnecessary heated and vitiated air into the mine, and reusing the return air has the same effect. In some mines the cold, fresh air from the surface is coursed along drainage tunnels taking relatively hot water out of the mine in open ditches, thereby transmitting higher temperatures to the ingoing fresh air.

25. At time of fire in a mine, lack of an efficient ventilation system may be disastrous. Each mine should have at least one main fan, which should be so placed as to be inaccessible to fire, have fireproof housing, be capable of quickly reversing the direction of flow of air currents if desired, and, preferably, be installed on the surface. There should be a definite system of air splits such that fire in one place may not necessarily fill the entire mine with poisonous fumes. This provision is vitally important, yet very few metal mines have made even a reasonable attempt to establish this excellent safety feature. There should also be a system of doors near shafts in the levels leading from shafts such that the entire shaft may be isolated readily in case of fire, or any part of the mine may be isolated from the shaft. If the main haulage road or hoisting shaft or slope is used to transport workers into or out of the mine, it should not be on return air; otherwise, lives are very likely to be lost because of poisonous gases in case of fire or explosion. The ideal system as to mine openings through which men travel or must be hauled or hoisted is to have such openings essentially neutral as to air flow and to supply them with only enough intake or fresh air to keep them free of gases, unduly cold air, etc.

26. Experimental work in mines reveals that after shafts that previously had ordinary exposed timbers are smooth-lined, friction generally will be reduced to such an extent that 50 per cent or more additional air can be handled by the same power. Preferably, at least the intake air shaft should be fireproof. If possible, all shafts or heavily inclined openings that carry air or through which men travel or are transported should be fireproofed, at least at the intersection and within several hundred feet of the intersection of such mine openings with the surface.

27. Although the cost of establishing a ventilation system for a large mine is variable, the expense of operation is not particularly burdensome and usually will be offset in a metal mine by savings in compressed air and by an increase in efficiency and health and safety of employees, which frequently will equal the entire cost of the investment within a few years. If a fire or explosion occurs, an efficiently installed and operated mechanical ventilation system is of incalculable value, and the absence of such a safeguard is likely to result in heavy loss of property and possibly of life.

Concluding Remarks

Ventilation has always been a primary requirement in the operation of underground coal mines, chiefly because of the possible occurrence of explosive gas, and virtually all of the countries of the world as well as the several States of the United States include ventilation requirements in the laws concerning coal mines. Ventilation requirements, legal or otherwise, for non-coal mines in the United States are and always have been inadequate. The State laws and State regulations as to the ventilation of coal mines range all the way from being fairly or reasonably complete to failing utterly to cover the ventilation requirements for health, safety or efficiency. Changing conditions in the relatively recent past have caused metal mines to do a much more effective job of distributing suitable quantities of relatively pure air to their underground employees, while on the other hand, recent changes in coal mining have more or less automatically decreased the ventilation efficiency of the coal mines of the United States rather than increasing it or even keeping pace with the trends of the times.

Many metal mines have acknowledged the trend toward the enactment of increasingly drastic laws concerning occupational disease (more especially dust disease) and have recognized that ventilation is one of the most efficient of the available methods of minimizing its occurrence. A number of large underground metal mines are now doing a fairly effective job of supplying underground workers with air of a suitable quality as well as in sufficient quantity to serve the needs of health, safety and efficiency.

The trend toward substitution of mechanized mining of coal for much slower *hand* methods of the past has had definitely detrimental influence on the effectiveness of ventilating coal-mine working faces; the result is apparent in the fact that practically all of the coal-mine disasters (fires or explosions) for the past several years have occurred in highly mechanized mines. The cause is readily apparent, but the remedy is not yet at hand. Mechanized mines cause the working faces to advance several times as rapidly as with the hand loading methods and this has very greatly increased the liberation of explosive gas and of finely divided (hence, highly explosive) coal dust. At the same time, makeshift ventilation methods have been introduced, such as the use of small portable blowers and flexible tubing. The result has been anything but satisfactory because the workers' lives are being sacrificed in far too numerous mine disasters because excessive volumes of explosive gas have been liberated and provisions for carrying it away are ineffective. Moreover, sources of ignition of gas-air accumulations have increased. Also, the dust content of the air in many of the mechanized working places under the greatly accelerated extraction of coal has become a menace to the health of those breathing it as well as a menace to their safety due to marked lessening of visibility in dust-laden air.

Another serious problem connected with coal-mine ventilation is the fact that with mechanized mining procedures, mines open vast areas of coal in a relatively short time, soon placing the working faces long distances (in some cases as much as several miles) from the mine openings. In many mines coursing of air in sufficient volumes through these long distances is difficult and in others almost impossible; hence, there is now a crying need for additional openings to the surface relatively close to the mine working faces. Newer methods of sinking circular 36- to 72-inch diameter shafts at relatively low cost may solve this particular problem, which certainly becomes more acute daily.

Mines must be adequately ventilated. Present conditions prove that more effective ventilation of our mines—especially those that produce coal—challenges the ingenuity of mining people and constitutes a worthwhile postwar project. Unfortunately, relatively little can be done during the present great demand for production.

Discussion

A. C. Bartlett, Boston, Mass. (Written): The opening statement in this paper wherein the author states that "Ventilation is the keystone of safety in underground coal mining, and of health in underground metal mining," cannot be too strongly stressed, and the frequency of headlines in the daily papers telling of mine disasters, due to mine explosions could, in the writer's opinion be greatly reduced by adequate ventilation.

The author very aptly compares a mine to a large building, and if we compare it to a windowless building, I believe that all of our members who are consulting engineers will agree that adequate ventilation cannot be obtained by merely creating an air movement along the corridors. For instance, how long would the occupants of the Pentagon Building in Washington continue to carry on their work if all outside windows were blocked, and the only ventilation provided was that due to movement of air along the corridor at a velocity of 1000, 2000, or even 5000 fpm?

In some mines, small auxiliary blowers are used to take air from the main corridors and force it through flexible tubing to the working faces, but these are almost universally of the same size, having a capacity of from 1500 to 2000 cfm, regardless of the size of the drift, and regardless of the number of men working at the face.

In my opinion, mine owners and mining engineers concerned with mine ventilation might well take a lesson or two from industrial engineers, who must solve ventilation problems encountered in the manufacture or use of explosives and explosive gases.

Many states, in which mining is a major industry, have adequate laws or regulations relative to mine ventilation but seem to have inadequate facilities for enforcing those regulations. Often the regulations are too general in their scope, and inspectors too lenient to compel the operators to carry out even the intent of the regulations.

The author points out that 15 or 20 years ago this subject of mine ventilation was discussed more than it is today. I believe this to be a fact, although, in my opinion, ventilation is more important today than it was then, and should be discussed even more.

It is my opinion that the lack of discussion is a result of unscrupulous competition which forces the operator to purchase inadequate ventilation equipment if he is to stay in business at all. This brings to mind that in those days of 15 and 20 or more years ago, and even today, it was not uncommon to see some ventilation equipment installed, which if tested by the Society's standard, have to show mechanical efficiencies in the range of from 93 to 100 per cent to equal the performance expected of it by the operator.

We also, perhaps, do not hear so much about respiratory diseases in mines as we formerly did, but that is probably no indication that they are less prevalent at this time than they were years ago, especially in mines where dry drilling is done. Although this part of the problem, in my opinion, is not so closely connected with the problem of ventilation as might be expected at first consideration, it is nevertheless a problem to which the mine operator should give careful consideration.

In localities where extensive cutting of granite and other stone is done, it is not uncommon to find regulations which require the installation of dust removal and collecting equipment, even though the operation is conducted out of doors. The problem is considerably worse in metal mines where the drilling is done in comparatively close quarters.

With the modern equipment designed for collecting dust, particularly in small units, it would seem that it would not be too much of an imposition on the operators to provide the drillers with a unit dust collecting system which would, in all probability, remove at least 80 to 85 per cent and perhaps 90 to 95 per cent of the siliceous dust from the air.

The use of compressed air for ventilation in blind ends or where drilling is done, is extremely inefficient as the author of the paper points out, and at the best, can only serve to stir up the dust and bring it to the breathing level of the miner.

Air conditioning in mines is not uncommon, particularly in the diamond mines of South Africa and in some of the other rare metal mines, and is almost a necessity for deep mining operations. The whole field of mining offers a challenge to ventilating engineers to bring about working conditions in mining industries, comparable to those enjoyed by workers in other industries because mining, at the present time, is not only hazardous from the viewpoint of explosion and bodily health hazard, but it is also in a great many cases, an extremely uncomfortable type of labor for the miner who has to carry on the actual work.

Again referring to the comparison of a mine with a building, it is not such a difficult matter to convince an architect who is designing a building, that he must provide certain areas, and certain shafts for the location of ventilation apparatus, ducts, etc., but it is sometimes a considerable undertaking for a mine owner to provide a separate ventilating shaft for the operation of ventilating equipment when the shaft has to be sunk anywhere from 2000 to 10,000 ft for that purpose.

The practice of ventilating a mine through the same shafts, corridors and drifts, that are used for the passing of the material as well as for the transporting of the miners should be discouraged, particularly in mines where the danger of explosions is present. Unless the direction of air flow in such an installation can be changed almost immediately in case of an explosion, an ensuing fire instead of being confined to a certain area of the mine, may be spread over a very much greater area, by the air currents.

It is my opinion that a great deal could be accomplished by additional regulations in some States, and by judicial, yet forceful application of already existing laws and regulations. Many mine owners, fortunately, do not object to the installation of proper ventilating material, if they are properly advised as to what the equipment really should do, and if they are given honest values and honest information.

DUBRY HEADS CENTRAL HEATING DEPARTMENT

Ernest E. Dubry has been appointed superintendent of the central heating department of The Detroit Edison Co. to succeed J. Herbert Walker, who was recently elected a vice-president. Other changes in central heating, recently announced by James W. Parker, president, were the appointment of Rudolph G. Felger as assistant superintendent in charge of plants and coaling stations, and G. D. Winans as assistant superintendent in charge of steam distribution and customer relations.

AWARD FOR WELDING PAPERS

Papers submitted for publication to the American Welding Society, 33 W. 39th St., New York 18, N. Y., describing original welding work done by the author or authors are eligible for this year's award of the Lincoln gold medal, which is given for "the greatest original contribution to the advancement and use of welding."

The donor of this annual award is J. F. Lincoln, president of the Lincoln Electric Co., and the presentation is made each year at the annual meeting of the AWS.

Principles of Ultraviolet Disinfection of Enclosed Spaces[†]

By L. J. Buttolph*, Cleveland, Ohio

SUMMARY—About 30 cu ft of fresh air per minute per child in school rooms, or the maximum *make-up air* in the best heating and ventilating installations, provides about 6 air changes per hour or 1 change every 10 min. This ventilation dilutes the air contamination at such a rate as to require a full hour for practically complete disinfection of a recently vacated room.

It is believed that for the prevention of the spread of respiratory diseases by air-borne bacteria and viruses an air purity such as that of summer living must be provided and that it could be approximated by ventilation at rates of 60 to 120 air changes per hour, or 1 to 2 changes per minute, if they were at all practical from the standpoint of draft, noise and cost. Such ventilation rates would completely decontaminate a recently vacated room in 5 or 10 min and would keep the concentration of bacteria in occupied and continuously contaminated rooms down to a safe level.

This sanitary ventilation can be easily added to the ordinary ventilation by upper- and lower-air disinfection with ultraviolet energy. In effect, zones of completely disinfected air are provided above, and sometimes below, the breathing level while under such circumstances a very slow general air circulation of 10 to 30 fpm, or 2 to 5 in. per second, provides the equivalent of the needed 60 to 120 air changes per hour.

Methods of calculating practical ultraviolet air disinfection installations are discussed in detail. An upper-air bacterially equivalent to outdoor air can be secured with one quarter to one half watt per square foot of ceiling area.

GERMS AND viruses of the common respiratory diseases are now known to be in the air of occupied rooms along with dust, odors and carbon dioxide. The occupants themselves are the unconscious sources of most of this contamination. With yeast cells and mold spores, the bacteria and viruses either float free in air as a living dust or are themselves attached to inert dust particles, or, in both forms, may be at rest on the walls and floor. The extent of the air contamination is only partially obvious in a motion picture projection beam or in a similar beam of sunlight through a darkened room because the bacteria and viruses themselves are too small to be individually visible even under such conditions.

The original sources of air contamination by pathogenic bacteria and viruses are generally the noses and throats of room occupants but the walls and floors and ventilating ducts become secondary sources of air infection which must be taken into account under some conditions. The immediate aim of air disinfection is to reduce the concentration of living air-borne pathogenic organisms at the breathing level by killing them and by dilution with air which is free of them.

A discussion of the probable mechanism of respiratory infection would be outside the subject of this paper if it were not essential for perspective as to the significance of the time element involved in the processes of contamination, disinfection, and the accumulation of pathogenic organisms in the human respiratory system.

Nose and Throat as Air Sampler and Filter

An important function of the nose and throat is the removal from breathed air of dust particles which include not only bacterial organisms enclosed in droplets of water, but especially the so-called *droplet nuclei* which are the particles of living dust left when the enclosing droplets of water, in which they may have been carried from noses and throats, have evaporated in space. As a consequence of this natural bacteria air filtering operation of the nose and throat, these cavities carry on their surfaces at all times a representative sampling of the dust and bacterial content of the air breathed by the individual for the many hours previous. For this reason every person is at times a carrier of pathogenic organisms awaiting only an opportunity, provided by mechanical lesions or the invasion of other sources of infection to make their own characteristic entrance into the underlying tissues as an active infection which may be diagnosed generally as streptococcic or virus, or specifically, as bronchitis or scarlet fever or measles or mumps, depending upon the organisms involved and the location of lesions.

Many of the organisms collected from air by the moist hairs and tissue folds in the nose and throat are, in turn, expelled from the nose and throat by coughing, sneezing and talking, as has been graphically demonstrated by photographic methods, to be again inhaled by another person. It is of special interest to note that even when the organisms are expelled in minute droplets of water these droplets are so small that most of them evaporate before coming to rest on a surface and the living dust particles float away to settle out of the air only after many hours.

Organisms which are not thus expelled from the nose and throat obviously do not remain there indefinitely, but are disposed of mechanically along with dust by the mucous secretions and the living organisms are, to some extent at least, destroyed by the natural protective and disinfecting action of the nasal and throat secretions. Thus we have a dynamic condition in which the actual concentration of living pathogenic and non-pathogenic organisms at any particular time may be represented as resulting from an equilibrium between the rate of collection from breathed-in air and the rate of disposal by expelled air and the body processes.

[†]Based on a paper presented at the Annual Meeting of the American Public Health Association, New York City, October 3, 1944.

*Engineer, Nela Park Engineering Div., General Electric Co.

It is obvious then that the concentration of germs in the nose and throat may be reduced by reducing their concentration in the breathed-in air by air disinfection. Here again we have a dynamic condition in which the actual concentration of living organisms in the air is an equilibrium between the rate of contamination by the healthy *carriers* and the diseased sources of infection, on the one hand, and the rate of decontamination, or disinfection, by the normal death of the bacteria themselves, by the filtering action of noses and throats, by dilution with fresh air and by the bactericidal action of chemical vapors or ultraviolet energy.

Time Rate of Collecting Bacteria

It is important to emphasize here that these processes are much slower than ordinarily realized as may be illustrated by the fact that a person can walk through a room containing an extremely high concentration of dust without acquiring a noticeable deposit in the nose while 6 to 8 hours in a room not visibly contaminated with dust will provide most obvious evidence of the effective dust filter the nose can be. The inference is that a person does not acquire a respiratory infection from a passing exposure to a sneeze but rather from a much longer exposure to such concentrations of respiratory disease organisms as are characteristic of enclosed and occupied spaces, and it is possible that the seriousness of the sneeze or cough as a momentary hazard to a passing person may have been over emphasized.

Time, the rate of change, is also very important in connection with any process of decontaminating or disinfecting air because its effectiveness is always relative to the continuing contamination and, in effect, the rate of decontamination must be greater than the rate of infection to secure any improvement in the condition of the air and equal to it for maintenance of the improvement. A rigorous analysis of the condition existing where the processes of contamination and disinfection are taking place concurrently is extremely involved and is seldom attempted because of the difficulty of determining the infection rate from human beings and in terms of the air sampling of pathogenic organisms. The problem can be simplified somewhat by the use of a mechanical infecting device or *infectee* as has been reported by Wells (1)[1] and used by many others. As is the case with milk and water, a dangerous concentration of pathogenic organisms may be difficult to determine by the available methods of sampling and indices of disinfection are used in practical work. In the laboratory artificially produced concentrations of harmless B-coli much greater than ever occur naturally with pathogenic bacteria, facilitate accurate determinations of the changes in concentration resulting from dilution or disinfection.

Summer Air and Ventilation

Since there is as yet very little correlation between the occurrence of air-borne transfer of respiratory diseases and directly determined concentrations of air-borne organisms, it seems best to work backwards from those conditions of natural ventilation known by experience to insure a minimum transfer of respiratory infection. It seems to be the opinion of those who have studied the problem that a ventilation rate of 120 air changes per hour is essential to duplicate the conditions of summer living, with 60 air changes as a minimum in any case and with 240 changes desirable under some conditions. Fig. 1 has been prepared to relate these rates of air change to those provided by current ventilating practice.

School Ventilation as an Example

Under average school housing conditions the 30 cfm of air per child, and the *make-up air*, in the best heating and ventilating systems, provides about 6 air changes per hour. This is one air change in 10 min, Fig. 1. This is a ventilating condition such that in the course of 10 min there is brought into a school room, for example, with theoretically perfect and continuous mixing a total cubage of air equal to the volume of the room. It is known that as a result of this process of dilution there will remain at the end of the 10-min interval, 36.8 per cent of the initial air, carbon dioxide, odor, dust and bacteria, a decontamination of 63.2 per cent. During the next 10 min there will be a further reduction of 63.2 per cent in the remaining 36.8 per cent of the initial bacteria, providing a disinfection at the end of 20 min of 86.5 per cent. As the process continues a practically complete disinfection of 99.99 per cent will only be reached after about 1½ hours of time, and 9-10 air changes, but this, it is important to note, is

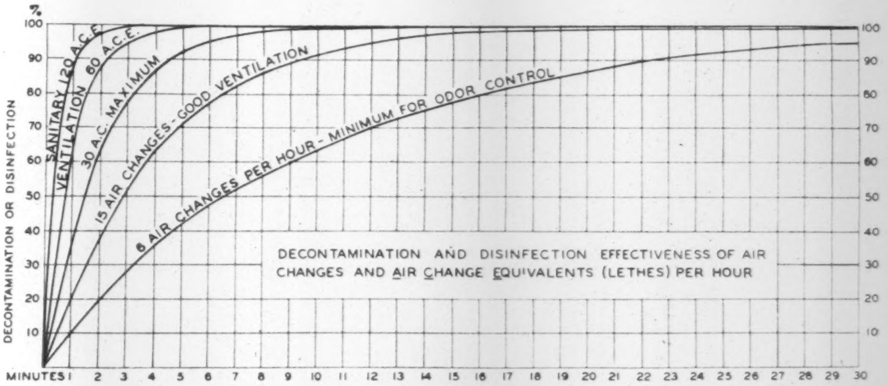


Fig. 1—Theoretical rates of air decontamination in rooms

under the condition that there is no continuing new contamination during the hour, in other words, the first hour after the children have gone home. In contrast with this ventilation which was originally specified for the disposal of carbon dioxide and odors it should be noted that the maximum practical by mechanical means of air circulation is 30 air changes per hour which would still require about 10 min to disinfect the air of a recently occupied room. In contrast with this maximum mechanical possibility and the fact that 15 air changes per hour represent deluxe ventilation, it should be noted that, since only the *make-up air* in any air conditioning system is effective in reducing the bacteria count, the air disinfection by dilution provided by current ventilation practice is much less than that illustrated by the schoolroom example. Although air filtering and washing to remove dust and odors may make it practicable to reduce this ventilation to 2 or 3 air changes per hour, sanitary ventilation of crowded spaces calls for a very greatly increased air change, in rooms of high occupancy, utterly impractical by mechanical methods.

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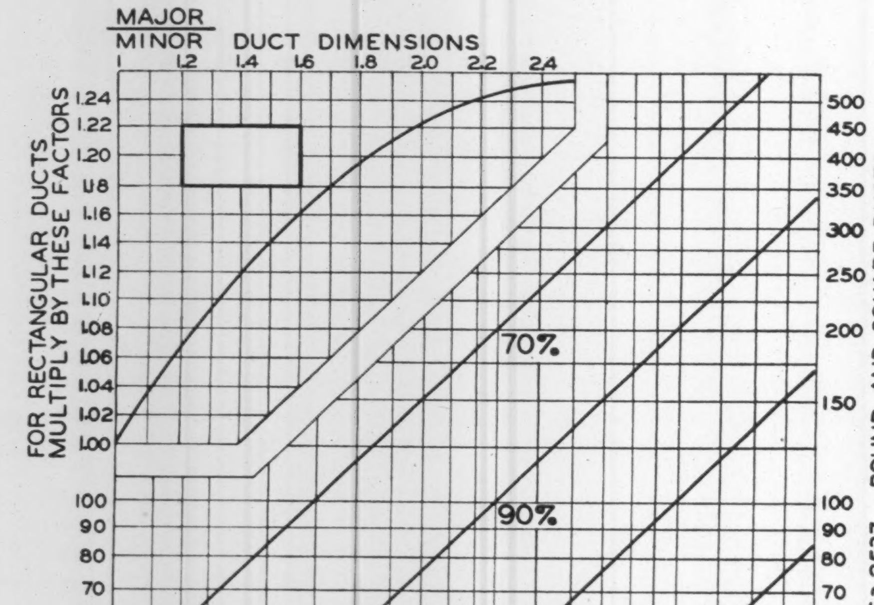
[1] Numerals in parentheses refer to Bibliography.



DUCT SHAPE AND REFLECTIVITY FACTORS BASED ON LUCKIESH & HOLLADAY DATA

Fig. 2—Chart for calculating ultraviolet requirements for various percentages of kill in air ducts

Sanitary Ventilation for High Occupancy

It is believed that for the prevention of the spread of respiratory diseases by air-borne bacteria and viruses in places where there may be about 200-300 cu ft of space per person, an air purity such as that of summer living must be provided. It is believed that this could be approximated by ventilation at rates of 60 to 120 air changes per hour, or 1 to 2 changes per minute, if they were at all practicable from the standpoint of draft, noise and cost. Such ventilation rates would completely decontaminate a recently vacated room in 3 to 6 min, as shown graphically in Fig. 1, and would keep the concentration of bacteria in occupied and continuously contaminated rooms down to a safe level.

Sanitary ventilation can be added to ordinary ventilation by irradiating the upper-air, about 7 ft, and sometimes the lower-air (below 2 ft), with an intensity of 2537A ultraviolet adequate to provide zones of completely disinfected air from which a very slow general air circulation of 10-20 fpm, or 2-3 in. per second, provides the needed equivalent of 60-120 air changes per hour in the breathing zone. This method of sanitary ventilation by upper-air irradiation will be discussed in detail later in this paper.

Less Sanitary Ventilation for Low Occupancy

It is probable that the sanitary ventilation requirement varies about inversely as the cubic feet of space per occupant, which means that in places where there may be 2000 to 3000 cu ft of air per occupant as in the home or in spacious offices, instead of 200-300 cu ft per person as in standard school rooms, one-tenth as much ventilation may be needed and 6-12 air changes per hour may be sufficient and practicable although seldom supplied by ordinary ventilation. Such a limited sanitary ventilation can be supplied by air disinfection with ultraviolet sources enclosed in air ducts or in individual room type air circulators of adequate capacity.

Ultraviolet Air Disinfection in Ducts

Although it is easily possible to disinfect all the air handled by a duct to bacterial equivalence to outside air, and thereby remove one of the objections to recirculated air, the mechanical limitations of practical duct capacities in the sanitary ventilation of rooms have been indicated. There still remain many cases where duct air disinfection is desirable, where the duct air is the principal source of room infection, where direct upper and lower air irradiation may be impracticable as in low ceilinged buses and railway cars, or where it may be desirable to disinfect recirculated air for the purpose of obtaining increased sanitary ventilation, or to justifying decreased make-up air. Since the recirculated air is usually four or five times the volume of the make-up air, disinfection of the former will increase four or five fold any disinfecting value which may have been credited to the latter, or disinfection of recirculated air may leave little need for make-up air except for odor and carbon dioxide control. In hospitals duct air disinfection may make air conditioning and heating by recirculation practicable to an extent not now thought safe or permissible.

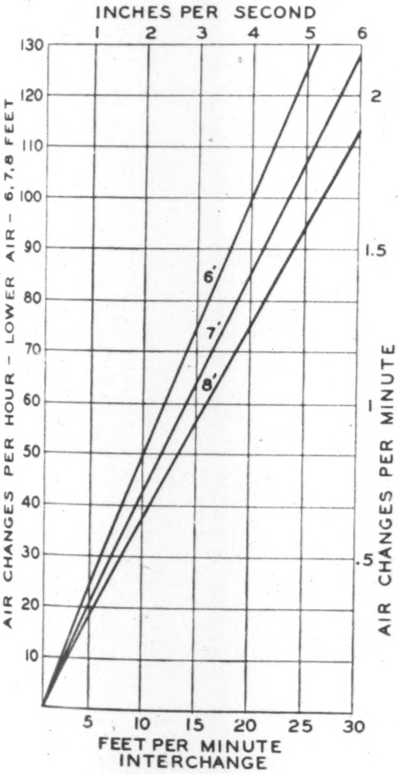


Fig. 3—The rate of sanitary ventilation in lower air of room by interchange with completely disinfected upper air

Practical Duct Calculations

Because of the way in which air ducts may be used to define the exposure factors of *intensity* (distance from the source) and *time* (minutes or seconds of travel through the irradiated zone) they have been used to secure the fundamental data on air disinfection (2, 3, 4, 5, 6). From these data and by methods described elsewhere (7), Fig. 2 has been prepared to simplify calculations of the amount of 2537A ultraviolet required for various air speeds and duct sizes, shapes and interior reflectivities. Because the absorption of 2537A energy by air, by bacteria or by any ordinary concentration of contamination is negligible, the output of a source is effective in producing lethal intensities through as many successive feet or in as many successive cubic feet as it can pass through before absorption by surrounding duct walls. This linear relationship between the average distance from the source to the duct walls and the cubic feet per minute (cfm) of air per watt of 2537A energy is fundamental to Fig. 2 and the effect of duct wall reflectivity and the increase of one of the duct dimensions is to increase the effective average distance the energy can travel before absorption and to increase the bactericidal effectiveness of the energy from the source. In laboratory work with one or two sources in large diameter ducts, non-uniformity of ultraviolet intensity through the cross section of the duct must be taken into account, but in practical work the number of sources used provides sufficient uniformity of irradiation and permits a choice of various ways of placing the sources in the ducts. In the practical use of Fig. 2 the cfm per ultraviolet watt of energy, based on the minor dimension of a duct, must be increased by a multiplying factor indicated at the upper left, for a rectangular duct, and by another factor indicated at the lower right, for reflective duct walls. For example, in a 30 x 60 in. duct with 60 per cent reflective walls and a rating of 12,500 cfm, a 99 per cent kill of bacteria would be produced in 50 x 1.22 x 1.5 or 91.5 cfm per watt of 2537A ultraviolet from the sources. This figure divided into 12,500 indicates a total of 137 ultraviolet watts which could be supplied by about 20 of the largest available germicidal lamps. This is provision for the most adverse conditions and it should be noted that the lethal exposures assumed by Luckiesh and Holladay (5) would indicate the use of but one half as much ultraviolet for the desired kill, and lethal exposures assumed by Wells (10) would indicate the need for still less ultraviolet, for the low relative humidity characteristic of the winter respiratory disease season. The writer suggests the use of the Luckiesh-Holladay value, or cfm ratings double those of Fig. 2, for practical work under average conditions.

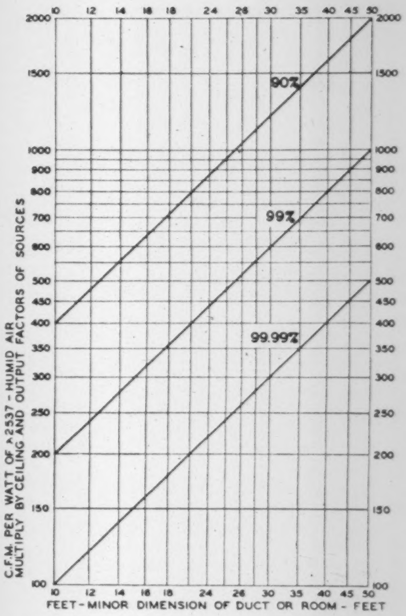


Fig. 4—Chart for calculating ultraviolet requirements for various percentages of upper air room disinfection

Room Air Disinfection

Since any room or enclosed space ventilated by a recirculating duct system may be thought of as an ex-

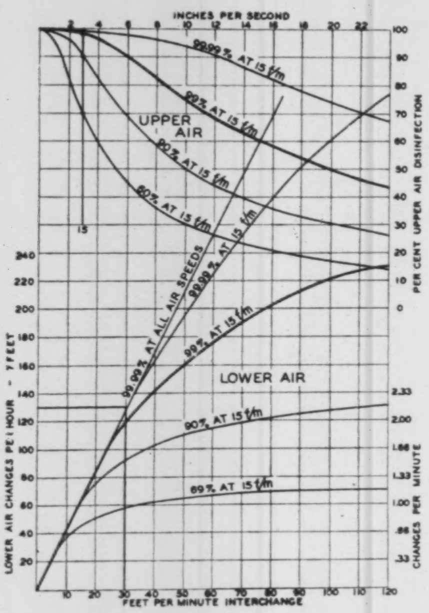


Fig. 5—Effect of varying air interchange on upper air disinfection and lower 7 ft air sanitary ventilation

treme enlargement of the duct itself, the advantage of large duct dimensions suggests placing ultraviolet sources directly in rooms needing sanitary ventilation. Not all of this advantage can be realized however, because ultraviolet intensities adequate to produce directly a sufficiently rapid bacterial disposal are also irritating to the eyes during the usual period of room occupancy and must be confined to the space above about 7 ft, with the addition in some cases of a space below about 2 ft (8). Such a method may be thought of as a 2-stage process in which intensive irradiation above a 7-ft level provides a reservoir of germ-free air which, in turn, serves to disinfect or dilute the contamination of the lower air as if by ordinary ventilating circulation or interchange of air. The usual first impression is that the interchange between these upper and lower zones is not sufficiently rapid to provide an effect of 60-100 air changes per hour in the lower zone. This impression often arises from a knowledge of the low rate of room air change provided by small ducts circulating air at a speed of 1000 fpm. Fig. 3 shows how effective low speed vertical air movement through one-half the cross section of a room at various levels may be, assuming a provision of ultraviolet sufficient to maintain a constant upper air disinfection. Such air speeds are very difficult to measure but may be observed locally in the movement of smoke in a light beam. This effective air interchange results from a great variety of components even under the simplest conditions. An important addition to such measurable circulation as may be provided by a ventilating or heating system, is the air movement caused by window and door leakage, by cold walls and windows, by heated radiators and light sources, by the body heat and breath of all occupants, and by the movements of occupants within the room.

Special attention is directed to the fact that most of this convective circulation is essentially vertical in direction and much of it is increased by the temperature and weather conditions of the respiratory disease season. The amount of this air interchange parallels to some extent the need for it. On the other hand, under theoretical conditions of no vertical or horizontal air movement at all, there would be little general air-borne transfer of infection from individuals to the group even though there still remained the droplet transfer problem (sometimes thought solved by the face mask) and some very slow transfer by diffusion.

Wells (9) has published some data, and he and others of the listed references have much unpublished data on bacterial concentrations in upper and lower air zones, which can in time be interpreted in terms of air interchange between the zones. Much additional data must be taken to cover all the practical combinations of spaces, ventilation, seasonal temperatures and occupancy. There are bacterial and clinical data to indicate that the air movement in school and hospital rooms, calculated from air samples, is adequate and is equal to that indicated in Fig. 3. Further experience however may indicate the desirability of some additional air movement, such as could be produced with center, ceiling hung, large diameter, low-speed air circulators operated concurrently with the ultraviolet sources.

Upper-air Irradiation

Wells (10) has analyzed the problem of upper-air irradiation in detail by integrating through typical spaces the products of distances and intensities to secure a measure of total effectiveness. Assuming an energy in watts per square foot which will kill 63.2 per cent of the bacteria in 1 min as a unit lethal intensity and this amount of kill as a unit of kill, the Lethe, he has emphasized *ray length* and has developed a concept of watts/ft² per foot of distance, or Foot-Lethes of irradiation, producing *Lethes* of bactericidal killing equivalent to air changes by ventilation. Lethes per minute or per hour of air disinfection, or

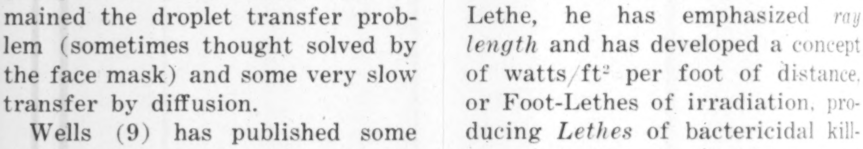


Fig. 6—Spatial distribution curves in vertical plane, of typical bactericidal lamp fixtures

sanitary ventilation, become equivalent to changes per minute or hour of air dilution by ordinary ventilation. As already noted, he has interpreted data, in terms of air circulation, on the differences in bacterial concentration in upper- and lower-air zones, with and without upper-air irradiation, working with B-coli atomized into the air to permit an accuracy in air sampling difficult to secure when working only with naturally occurring bacterial contamination. Luckiesh and Holladay (11) have extended their accurate measurements in ducts to the room condition by considering it as divided by a partial horizontal diaphragm, in the plane of the ultraviolet sources, into upper and lower ducts in series, with air speeds through them inverse as their cross section, an air movement which they point out must be provided by artificial means if not naturally adequate.

In view of the basic importance of this upper- lower-air interchange the writer tentatively offers a slight modification of the duct analogy by treating a whole room as a large vertical duct in which there is a continuous vertical interchange of air through the horizontal plane of the ultraviolet sources. This interchange may be represented as an upward movement through one-half of the horizontal cross section of the room and a corresponding downward movement through the other half, considered as: (1) a duct whose minor dimension determines the basic spatial effectiveness of the ultraviolet as in an ordinary duct but whose major dimension does not practically modify this rating because of the transverse placement of the sources and their essentially elliptical iso-intensity characteristics in the plane of the tube shown in Fig. 9; (2) a duct in which the wall reflectivity must be kept below 10 per cent and otherwise may be disregarded; (3) a duct whose effective length may vary over a wide range determined by the ceiling height of the room and which must be taken into account in all calculations; and (4) a duct in which the air movement is widely variable (for reasons already discussed) and which must be assumed, for purposes of calculation, from such empirical data as are available. Fig. 4 extends the duct data of Fig. 2 to the larger cross sections and the lower air speeds characteristic of such room conditions and may be used for practical work in a similar way. Cfm ratings per watt of 2537A energy are modified by two multiplying factors covering the per cent output efficiency of the germicidal fixtures used and their per cent effectiveness as determined by the inter-relationship of their distribution characteristics and various ceiling heights. These factors are both inherently characteristic of the various individual fixtures and should eventually be made available by the manufacturers through recognized testing laboratories. The only other variable unknown essential for practical work with Fig. 4 is the air interchange factor which is characteristic of each installation and is dependent upon a great variety of local conditions already mentioned.

Air Interchange Factors

Because the actual air movement is random over the whole room area and in every possible direction it is impracticable to attempt direct measurement of air interchange factors or effective speeds of air movement vertically through one half the room cross section. These factors can only be determined indirectly by calculation from such measurements as Wells (9) has made of the lower air dilution resulting from the interchange with upper air disinfected to various measurable degrees. Although considerable air sampling data subject to such an interpretation have been taken little data have been published. Until much more data covering a full range of ventilating and climatic conditions are available tentative factors only can be used and the following are suggested; schools 15-30, hospitals 15-25, offices and factories 10-15. The direct dependence of lower air disinfection by dilution upon the air interchange factor, shown in Fig. 3, was that which is characteristic of various design conditions in which the amount of ultraviolet energy is varied in proportion to the air movement to maintain a uniform per cent of upper air disinfection. In practice, the amount of upper air disinfection is defined in the design of any one installation by the assumed average air interchange factor from which the cubic feet of air per minute in circulation is calculated, and by the amount and effectiveness of the ultraviolet energy provided in accordance with Fig. 4.

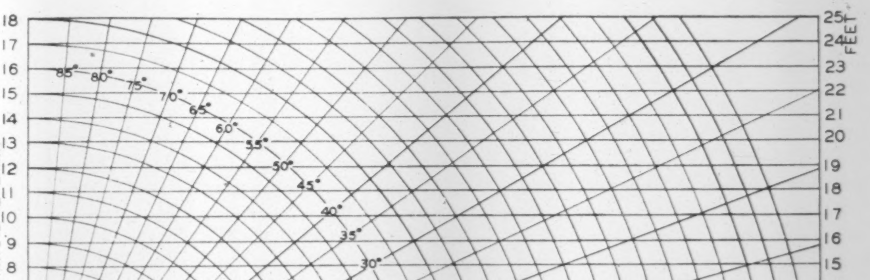


Fig. 7—Chart for calculating ceiling factors of various bactericidal lamp fixtures from their distribution curves

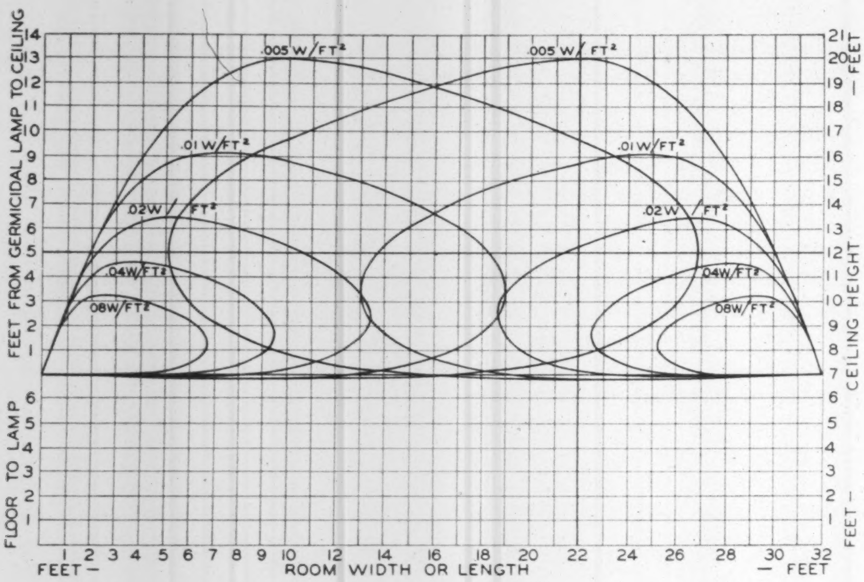


Fig. 8—Iso-intensity curves in vertical plane and for typical bactericidal fixture, superposed on schoolroom dimensions for graphic appraisal

It is, therefore, important to know how the variations in the air interchange factor (produced by seasonal temperatures, movement of occupants, fans, etc.) affect the disinfection of the upper air and also how they affect its effectiveness, in turn, as a diluent of the lower air. This complicated interrelationship is shown graphically in Fig. 5 which represents a condition of equilibrium such that the destruction of bacteria above equals their introduction below and in the combined process there are surviving bacteria only because of the time interval between their introduction below and their exposure to ultraviolet energy above and because there is also a time lag inherent in their coincidental logarithmic death rate above and the dilution rate below. While the per cent of upper air disinfection represented in the upper part of Fig. 5 can be calculated from the available duct data only the rate of decontamination below can be predicted. The actual reduction in bacterial concentration below can be calculated only from a knowledge of the rate of contamination characteristic of each individual local condition and reliable data on this are only to be had by direct air sampling methods.

It is to be noted that an increase of air movement decreases the per cent of disinfection of the upper air by irradiation and, proportionately, its effectiveness as a diluent, but, in spite of this the increased air movement increases the rate of lower air disinfection by dilution. Fig. 5 also shows that although sanitary ventilation is proportional almost solely to the air movement at lower rates, it becomes at the higher rates of air movement characteristic of winter temperatures and the respiratory disease season, very dependent upon and is limited by the degree of upper air disinfection, and by the amount and effectiveness of the ultraviolet irradiation.

Per Cent Output, Fixture Efficiency

Fig. 6 presents the distribution curves in conventional form in a plane perpendicular to the tube, of 3 typical bactericidal lamp fixtures equipped with aluminum reflectors. The figures for watts per square foot at 10 ft may be converted to microwatts/cm^2 at 1 meter by multiplying by 10,000. The inner curve represents the energy obtained directly from the tube only, while the outer curve represents the total from the tube and reflector. Distribution curves in the plane of the tube are all similar in shape and approximately circular and therefore are not shown. For practical purposes an index of total output may be secured by adding the intensity ratings at 5 deg intervals and dividing the sum by the product of the bare tube rating by the number of 5 deg intervals around it. Table 1 was calculated in this manner from the original curves of Fig. 6. The low effective output of Type A, in comparison with B, is due to energy lost to the increased reflector surface and to the sidewalls above the unit, losses which are greater than the total loss to the extensive reflecting surface of Type C.

Effective Output Factors

The effective output factors of fixtures, such as Type C, Fig. 6, with an exit angle of 90 deg or less, is double the per cent output because the effectiveness of such fixtures is not modified by the nonreflecting wall on which they may be mounted. This is in contrast with the bare sources, on which Fig. 4 is based, one half of whose output is absorbed when they are mounted in contact with a nonreflecting wall. For a bare lamp or a fixture such as Type B, Fig. 6, having an output distribution curve which is symmetrical relative to the duct or room axis and walls, the per cent output is also the *Effective Output Factor.* The effectiveness of such units, the integrated product of output and distances in all directions, remains practically constant regardless of their location from the center to contact with the side walls because the decreasing distances to the near walls are compensated by the increasing distances to the far walls.

Ceiling Absorption Factors

Figs. 2 and 4 are based on the assumption that there is no ultraviolet absorption in the duct or room except that of the walls and with provision in Fig. 2 for reflective walls. In applying Fig. 4 to room conditions however, ceiling absorption becomes important and equivalent to an absorbing medium through the cross section of a duct. To illustrate this and to facilitate the calculation of ceiling factors Fig. 7 presents the distribution curves of fixture Types A and C of Fig. 6 superposed on a scale diagram of typical room dimensions. A study of the conditions indicates that the ceiling factors of any one fixture may be practicably deter-

Table 1—Output and Effective Output Factors for 3 Typical Bactericidal Lamp Fixtures with Reflectors Shown in Fig. 6.

	A	B	C
Output of bare germicidal lamp per cent	100	100	100
Output directly from lamp (Fig. 6) per cent...........	27	50	20
Output from reflector only (Fig. 6) per cent..........	18	35	32
Output total effective from fixture (Fig. 6) per cent...	45	85	52
Effective Output Factor (Fig. 4)	0.90	0.85	1.04

Table 2—Ceiling Factors

	Feet—Distance from Fixture (lamp center) to Ceiling														
Type	1	2	3	4	5	6	7	8	9	10	11	12	13	18	23
A	0.06	0.12	0.17	0.23	0.28	0.33	0.37	0.41	0.45	0.49	0.53	0.56	0.60	0.75	0.87
C	0.16	0.25	0.35	0.42	0.48	0.54	0.58	0.64	0.67	0.70	0.73	0.76	0.78	0.88	0.96

mined solely from its distribution curve in a plane perpendicular to the tube as was done in calculating the fixture output factor. Such ceiling factors are calculated as the ratios of the sums of the products of the intensities at 5 deg intervals and the corresponding distances to the side wall and ceilings at various heights, to the sum of the products of the intensities at 5 deg intervals and the corresponding distances to the side wall and to a theoretical ceiling at the side wall distance. Table 2 is for ceiling absorption factors so calculated from Fig. 7, on the basis of a 30-ft distance to the wall and ceiling, and for the typical distribution curves of Fig. 6. The first three columns show the importance of even 6-in. differences in distance to the ceiling in the case of 8- and 9-ft ceiling heights where the lowest possible fixture mounting is indicated—even as low as 6 ft in some cases. The first 8 columns show the difference in effectiveness of the two types of fixtures under low ceilings, a considerable difference until the ceiling heights exceed 16 ft. These factors and the effective output factors should indicate to the most casual reader the importance of the germicidal fixture design in relation to its use. The use of louvers for appearance or use of inadequate reflectors may provide fixtures of practically no value, especially when used in rooms of ordinary ceiling height.

Depreciation and Lamp Variation Factors

It is important to note that, because of the logarithmic nature of the ultraviolet bactericidal action, changes of source output due to depreciation and individual source variations usually expressed in per cent do not at all result in the same per cent changes in air disinfection as has been more fully discussed elsewhere (7). Thus, as an extreme example, a 50 per cent depreciation in source output would result in a decrease in air disinfection from 99.99 per cent to 99 per cent or from 99 per cent to 90 per cent, or from 90 per cent to 70 per cent, depending upon the initial per cent of kill. Too little is known, however, regarding the relative clinical values of the higher rates of kill represented by 99 per cent and 99.99 per cent, the latter representing, for example, a survival of 1 organism in 10,000.

Upper-air Calculation

Fig. 4 is based on bactericidal exposures effective under the more adverse conditions of practical use and may be used with but small additional factors of safety to cover source depreciation. For example, assume that a school room 22 ft by 32 ft with a 12 ft ceiling is to be equipped with Type C bactericidal fixtures mounted on the sidewalls 7 ft from the floor, or 5 ft from the ceiling. The output factor would be 1.04 from Table 1, the ceiling factor 0.48 from Table 2, and an air interchange of 15 fpm may be assumed for fall and spring conditions. The total effective air movement in the room is therefore 5300 cfm upward through one-half the room cross section at the 7-ft level and downward through an equivalent area. For a room width of 22 ft, Fig. 4 indicates a basic rating of 425 cfm per watt of 2537A energy from the ultraviolet sources used for a 99 per cent kill. This rating multiplied by 1.04 and by 0.48 becomes 212 cfm and this divided into 5300 indicates 25 watts of ultraviolet as if from bare

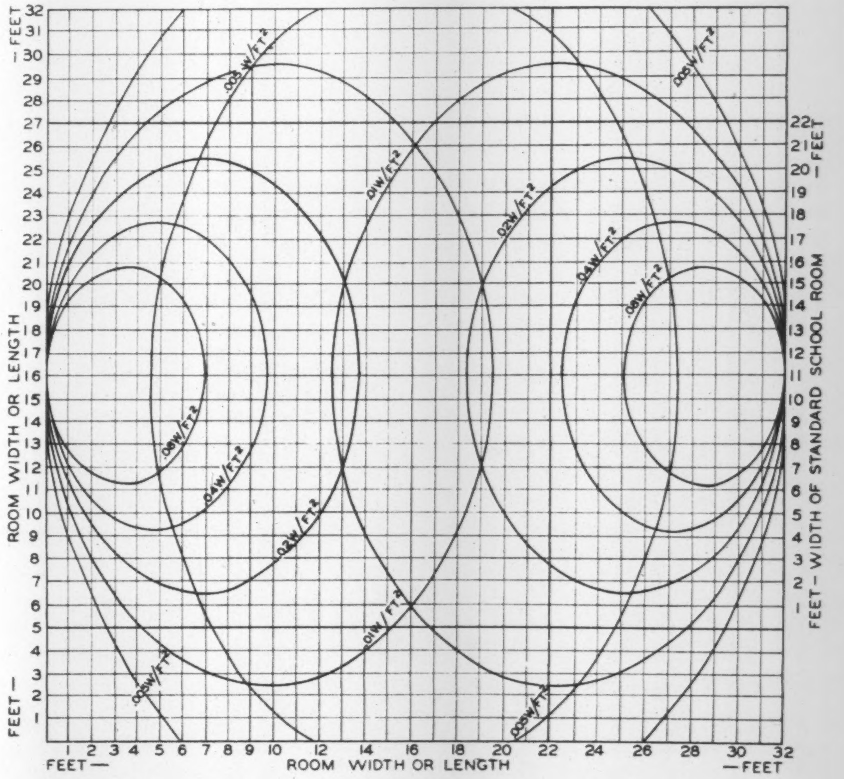


Fig. 9—Iso-intensity curves of typical bactericidal fixture in plane of tube and direction of maximum intensity, superposed on typical schoolroom dimensions for graphic appraisal

sources, a requirement which could be amply met with 4 typical germicidal lamps rated at 7.2 watts of 2537A each, or with 9 smaller commercial units rated at 2.9 watts each. Reference to Tables 1 and 2 indicates that approximately double these numbers of fixtures of Type A would be required, the products of the output and ceiling factors being in the ratio of 0.50 to 0.25. This is provision for the most adverse conditions and it should be noted that the lethal exposures assumed by Luckiesh and Holladay (5) would indicate the use of but one-half as much ultraviolet for the desired kill—and exposures assumed by Wells (10) would indicate still less ultraviolet—for the low relative humidity characteristic of the winter respiratory disease season. The writer suggests the use of the Luckiesh and Holladay value or cfm ratings double those of Fig. 4, for practical work under average conditions.

Lower-air Calculation

Assuming such easily obtained and practically complete disinfection of the upper-air by irradiation as is illustrated by the foregoing example, the corresponding lower air disinfection by dilution results directly from the air interchange characteristics of the room. In the foregoing example the total effective air circulation was 5300 cfm into the lower zone of 4928 cu ft to produce 1.07 changes per minute or 65 changes per hour, a result indicated directly in Figs. 3 and 5 for a fixture mounting height of 7 ft and an air interchange rate of 15 fpm. The variation in disinfection with seasonal changes in this air interchange rate is shown in Fig. 5, where the above example is illustrated by the heavier lines and a design for a 99 per cent upper air disinfection at 15 fpm.

Graphic Fixture Appraisal

Figs. 8 and 9 serve to illustrate the use of iso-intensity curves which are calculated for fixture Type C and are superposed on room dimensions as in a typical standard school room installation for a graphic appraisal of the distribution of ultraviolet in space. Note that the curves of Fig. 8 are in the plane of maximum intensity 10 deg-13 deg from the horizontal and that in both cases energy incident at any given point in space from different directions is fully additive in a sense not true in illumination practice although such sums are not indicated in Figs. 8 and 9. The relationships between various ceiling heights and the iso-intensity curves should be noted especially in Fig. 8.

Epidemiologic and Clinical Factors

When sufficiently sensitive methods of air sampling are available to permit determination of actual concentrations of pathogenic bacteria and viruses in occupied rooms and when such data are correlated with epidemiological and clinical data on the incidence of respiratory disease the data on per cent kill in this paper will indicate how to secure and maintain a space concentration below any specified critical value. The writer believes that a specification of such critical values and the interpretation or discussion of sanitary ventilation from the standpoint of room occupancy, occupant infection and susceptibility and the virulence of the current respiratory disease to be a part of the bacteriologic and epidemiologic basis rather than the physical basis of air disinfection.

Although the physical factors covered in this paper are fundamental to any proper use of ultraviolet air disinfection their final application must be further conditioned on equally important factors related to the prevalence of respiratory disease and the susceptibility and crowding of the people involved. To whatever extent these bacteriologic and epidemiologic factors are uncertain assumption of the worst probable conditions is suggested in the provision of correction by sanitary ventilation.

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FRANK NUNLIST APPOINTED

Frank J. Nunlist, Jr., a member of the Society and acting chief engineer for the past year for the L. J. Mueller Furnace Co., has been appointed chief engineer. Mr. Nunlist has been active in the heating and air conditioning industry since 1931, and has been associated with L. J. Mueller since 1940.

He is a member of the ASHVE Code Committee for Testing Heavy Duty Furnaces, as well as a member of the technical committee of the National Warm Air Heating and Air Conditioning Association. He is also a member of the Engineering Society of Milwaukee, and an industry panel member of the War Labor Board.

Standing—left to right: K. H. Flint, Prof. G. L. Tuve, Prof. D. K. Wright, Jr., Cyril Tasker and L. L. Simmons. **Seated—left to right:** G. V. Parmelee, Ernest Szekely, H. F. Hagen and R. D. Madison.

Laboratory Studies—Air Duct Friction

THE SOCIETY'S Technical Advisory Committee on Air Distribution and Air Friction is sponsoring studies on the subject of air duct friction at the ASHVE Research Laboratory, Cleveland, Ohio. Serving under the Chairmanship of Ernest Szekely, Milwaukee, Wis., are: S. H. Downs, Kalamazoo, Mich.; S. L. Elmer, Jr., Syracuse, N. Y.; K. H. Flint, Cleveland, Ohio; W. H. Hoppmann II, Brooklyn, N. Y.; F. J. Kurth, New York, N. Y.; J. H. Livermore, Detroit, Mich.; D. J. Luty, Detroit, Mich.; R. D. Madison, Buffalo, N. Y.; Prof. L. G. Miller, East Lansing, Mich.; Prof. D. W. Nelson, Madison, Wis.; Prof. G. B. Priester, Cleveland, Ohio; L. P. Saunders, Lockport, N. Y.

A sub-committee, appointed by Chairman Szekely and consisting of: R. D. Madison, *Chairman*; S. H. Downs, L. P. Saunders, K. H. Flint, H. F. Hagen, L. L. Simmons, and Prof. D. K. Wright, Jr., assumed active responsibility for these studies and held a conference for this purpose at the Laboratory on April 5. The primary purpose was to consider a report which had been prepared by Professor Wright, working on an assignment for the Committee on Research at the Society's Research Laboratory, on the following aspects of the subject of air duct friction:

a. A comparison of basic source data.

b. A comparison of the present friction chart in THE GUIDE with similar charts or tables in use by various organizations or recommended in handbooks and textbooks.

In presenting his report, Professor Wright stated, "Authorities in the field of fluid mechanics are in essential agreement as to the general equations governing the friction of fluid flowing in closed round pipes. These relations have been employed by Rouse and by Moody in preparing charts from which the friction coefficient can be determined. It has been definitely established that these charts are valid for a large number of fluids, of which air is one. Since any practical set-up for testing the friction of ventilating ducts is limited as to sizes of ducts which can be tested and to velocities which can be reached, such tests as were made in the past generally have been restricted to conditions which obtain in the lower portion of the friction chart. This limited range of results leads to an equation which can be greatly in error if extrapolated sufficiently to include the range of the usual friction chart." In view of the general acceptance of the basic functions, Professor Wright suggested that "it would be a better procedure to use the results of tests on ducts to evaluate the one unknown in the equation, i.e., the roughness parameter, and to make up the proposed friction chart on that basis. If enough reliable data are available, both the magnitude of the roughness parameter and its variation with duct size can be determined from a very simple analysis. If such data are not available, this scheme promises results with a minimum of testing. The data examined so far indicate that a roughness parameter equal to 0.0005 ft is not far from the proper value for ducts of about 12 to 24 in. in diameter."

It was pointed out that the friction charts now in general use tend:

1. To give friction values too low in the upper range if satisfactory in the low range, or too high in the middle if satisfactory at top and bottom.
2. To over-emphasize the effect of change of diameter in the low velocity range.
3. To under-emphasize the effect of change of diameter in the high velocity range.

Six of the members of the subcommittee met with Professor Tuve, Chairman of the Committee on Research, and members of the staff of the Laboratory at this conference and took part in a very lively discussion on Professor Wright's report and on the whole subject of air duct friction, which is of great interest to so many members of the Society and to others. The following conclusions were drawn:

1. The Committee accepted the report and recommended that the study be continued and that a tentative friction chart be prepared on the basis of Moody's work, published in November 1944, in the Transactions of ASME using a value of 0.0005 ft for the roughness parameter. This tentative chart is to cover round pipe only, with workmanship and interior smoothness defined.
2. A paper will be prepared for presentation through the Technical Advisory Committee on Air Distribution and Air Friction and for publication in the Society JOURNAL. The Committee hopes that the material in the paper will subsequently prove to be of value for textual material in THE GUIDE, 1946.
3. It was the consensus of opinion that for the present it would be satisfactory to follow the old practice of establishing equivalent rectangular ducts based on the mean hydraulic radius, but it was recommended that a project be set up at the laboratory as soon as possible to verify, by test, the actual relationship for ducts hav-

ing an aspect ratio from 1 to 1 to 1 to 6.

4. It was also recommended that a study be undertaken on losses in elbows, fittings and transformations, the first step being to collect data already available from various sources in the literature, including that developed by the Brooklyn Navy Yard and the NACA. The Committee recommended that in addition to a search of the literature, test work be undertaken at the Society's Research Laboratory. Mr. Madison agreed to advise on the suggested test methods.

Several suggestions were made with regard to the method of plotting a friction chart, and it is expected that THE GUIDE 1946 will contain not only a new friction chart, but a friction chart printed in a different way than it has been heretofore. The Guide Publication Committee, at its meeting in New York on April 12, recommended that the chart be prepared and, if acceptable, utilized in the next edition.

There is a great deal of interest in this project among many branches of the industry and also among allied organizations. The American Gas Association, through its Industrial Gas Section, is particularly interested in this phase of the Society's research work and has offered, in cooperation with other interested bodies, to sponsor experimental work at the Laboratory to provide accurate, usable and generally accepted data for air duct friction in straight duct, elbows, fittings, transformations, and the like.

As the staff situation at the Laboratory eases, this work will be pursued with the utmost vigor. Any member interested is invited to correspond with the Director of Research or with Chairman Ernest Szekely of the Technical Advisory Committee, and is, in particular, requested to furnish the Laboratory and the Committee with any data which may have been privately collected and assembled. The Committee, through Mr. Szekely, says: "If *you* have information, send it to *your* Laboratory, so that the rest of the membership may share, with those especially experienced in these matters, information which is of such fundamental importance to all those sections of the industry which are in any way concerned with the handling of air."

PARMELEE RECEIVES DEGREE

George V. Parmelee, Research Fellow at the Society's Research Laboratory in Cleveland, was awarded the degree of Master of Science in Mechanical Engineering by Case School of Applied Science, Cleveland, Ohio, at the graduation exercises held in Severance Hall on April 21.

George Parmelee

Mr. Parmelee is on leave of absence from Fenn College, Cleveland, where he is Assistant Professor of Mechanical Engineering. He graduated from Fenn College in 1933, worked in the House Heating Division of the East Ohio Gas Co., Cleveland, later studied at Iowa State College, and has been on the staff of Fenn College since 1938.

He came to the Society's Research Laboratory in July 1944, to work on a project dealing with Heat Transmission Through Glass under the Technical Advisory Committee on Glass. A comprehensive report was presented to the members of the Glass Committee at the meeting held in Boston in January, and as a result the Committee approved further work on the following important aspects of this subject.

1. A study of the effect of length of surface and depth of window recess on the outside film conductance.
2. Solar transmission through glass as affected by solar intensity, temperature difference between indoor and outdoor air, angle of incidence, and absorption characteristics of the glass. The effect of shading will also be studied.

This work is now in progress at the Research Laboratory. Mr. Parmelee was recently admitted to membership in the Society.

GRAHAM NEW MANAGER FOR TRANE AT GREENSBORO

William D. Graham, a member of the Society since 1923, and a registered professional engineer in the state of Ohio, has been appointed branch office manager for The Trane Co., La Crosse, Wis., at their Greensboro, N. C., office. This office, located at 504 Jefferson Standard Bldg., will serve the greater part of the North Carolina territory, specializing in the manufacture of heating, cooling, air conditioning and air handling equipment.

Mr. Graham is well known in the field and has specialized in various applications of heating and air conditioning equipment for over 20 years. Previous to his recent association with The Trane Co., he managed the Industrial Heating and Ventilating department for a prominent manufacturer of heating equipment.

POPE ELECTED OFFICER IN BCEA

At the annual meeting of the Board of Directors of the Building Construction Employers Association of Chicago held recently, the following officers were unanimously elected: President, O. A. Reum; 1st Vice-Pres., William McGuineas; 2nd Vice-Pres., G. V. Dahl; 3rd Vice-Pres., S. Austin Pope; 4th Vice-Pres., R. M. Moffitt; Treas., W. H. Ericsson.

Mr. Pope, the only newcomer in the group, succeeds the late Fred C. Black. He is president of William A. Pope Co., Chicago. He received his M.E. from Cornell in 1914, became a member of the ASHVE in 1917, and has taken an active part in Chapter affairs.

GATES, MOE AND WEISS FORM PARTNERSHIP

Parker A. Moe, Milwaukee, Wis., a member of the ASHVE, has formed partnership with Samuel J. Gates and Robert H. Weiss, to engage in the practice of engineering. Mr. Moe will specialize in power and heating plant design, and in the improvement of operating efficiencies of existing power and heating plants. For the past 15 years he has been employed as chief engineer of power for the International Harvester Co., Milwaukee Works. His long established record of high operating efficiency of this plant is well recognized, and his method of operation has been copied widely. In the past 10 years he has acted as advisory engineer for several industries in Milwaukee for the selection and layout of their power plants.

Each of the members of this new firm holds membership in the Engineers Society of Milwaukee. Mr. Gates is a member of the ASME and the Society of American Military Engineers, while Mr. Weiss and Mr. Moe are members of the National Association of Power Engineers. Mr. Moe is also past State President of the latter association, and served as chairman of its National Educational Committee for three years.

In March 1944, Mr. Moe was appointed by the U. S. Department of the Interior as Fuel Co-ordinator for the Milwaukee area.

The new firm is to be known as Gates, Moe and Weiss, and with the diversified engineering backgrounds of its partners, will assure complete coverage of engineering projects.

McINTIRE HEADS U. S. RADIATOR

James F. McIntire, Detroit, Mich., past president of the ASHVE, has been elected president of the U. S. Radiator Corp., according to a recent announcement.

Mr. McIntire received his B.S. in 1907 from the University of Illinois. His first assignment was with J. S. Farrell and Co., Indianapolis, Ind., as superintendent of plumbing and heating departments, and before joining the staff of the U. S. Radiator Corp. in 1910 he spent three years with the U. S. Heater Co. as salesman, draftsman and engineer. His first position with the U. S. Radiator Corp. was as boiler engineer, specializing in designing and testing.

J. F. McIntire

Mr. McIntire joined the ASHVE in 1914 and has devoted a great deal of his time to Society activities both nationally and in the Michigan Chapter. He served on many technical committees as well as chairman of the Finance Committee from 1936-1938, inclusive, as a member of the Council in 1936-1937, as Second Vice-President in 1937, First Vice-President in 1938 and as President during 1939.

READING LIST FOR JUNIOR ENGINEERS AVAILABLE

A revised *Reading List for Junior Engineers* has been issued by the Junior Committee on Professional Training of the Engineers' Council for Professional Development and is now available for distribution.

It has been assumed that most engineers will know the great and familiar works of literature and religion, such as Shakespeare's plays, Milton's poems, the Bible, and the novels of such authors as Dickens, Stevenson, and Mark Twain.

The committee's purpose was the "guiding of the young engineer to proper and competent sources of cultural and intellectual fields outside of the specific profession."

PRODUCERS' COUNCIL ELECTS L. C. HART

L. C. Hart, vice-president of the Johns-Manville Sales Corp., was elected president of the Producers' Council, national organization of manufacturers of building materials and equipment, at the annual meeting held last month. Tyler S. Rogers, Owens-Corning Fiberglas Co., was chosen first vice-president, and Gordon C. Hay, Fiat Metal Mfg. Co., was re-elected second vice-president. Frank A. Sansom, Chamberlin Co. of America, continues as secretary of the council, and Allen E. Pearce, Armstrong Cork Co., was named treasurer.

Newly elected directors of the organization are Charles A. Snyder, Richmond Screw Anchor Co., Fred L. Riggin, Jr., Mueller Brass Co., Henry W. Collins, Celotex Corp., and Lawrence Jennings, General Electric Co., North A. Wright, Libbey-Owens-Ford Glass Co., and Irving W. Clark, Westinghouse Electric Corp., were renamed to the board.

At the 51st Annual Meeting, Boston, Mass.

Pres. S. H. Downs
Kalamazoo, Mich.
Opens the Meeting

Dr. B. M. Woods
Berkeley, Calif.
Reports on Finances

M. F. Blankin
Philadelphia, Pa.
Reports Membership
at All Time High

General Chairman
Earl G. Carrier
Boston, Mass.,
Greets Visiting
Members

Treas.
L. P. Saunders
Lockport, N. Y.
Gives Treasurer's
Report

SUMMARY OF LOCAL CHAPTER MEETINGS

Chapter	Meeting Date	Subject	Speakers	Other Features	Attendance	Attendance Ratio*
Central Ohio	Mar. 12	Automatic Controls (lantern slides)	J. R. Vernon, Johnson Service Co., Milwaukee, Wis.	Treasurer's Report was submitted	33	0.55
Cincinnati	Mar. 13	Characteristics and Uses of Automatic Control Equipment for Air Conditioning	J. R. Vernon, Johnson Service Co., Milwaukee, Wis.	A rising vote of thanks was given to Mr. Vernon	31	0.63
Connecticut	Apr. 11	Air Conditioning in Latin America	Alfred J. Offner, 1st Vice-Pres. of ASHVE, New York, N. Y.	Pres. Teasdale expressed thanks to I. C. Jennings, Pres. of Nash, who welcomed all to the plant	66	1.3
		Inspection trip through Nash Engrg. Co. plant, South Norwalk, Conn.	C. J. Lyons was given a vote of thanks for making all arrangements for meeting. His resignation from Nash was announced and wishes for success in his new venture were extended by the Chapter			
Delta	Apr. 10	Multi-Room Air Conditioning	Norman E. Bueter, Sales Dir. of Comfort Air Conditioning, Carrier Corp., Syracuse, N. Y.	Interesting discussion followed and a vote of thanks was given to the speaker	43	0.65
	Mar. 13	The Telescope Equipment (Tulane University Observatory).	Prof. J. Adair Lyons, Meteorologist of Tulane University, New Orleans, La.	The meeting adjourned to Tulane University Observatory to hear Dr. Lyons discuss and demonstrate the telescope equipment	18	0.50
Golden Gate	Mar. 7	Ship Ventilation	R. P. Mason, Engr., Design Section, U. S. Army Transport Service Hdqrs., San Francisco, Calif.	Considerable discussion followed. Nominating Committee was appointed	47	0.58
Illinois	Apr. 9	Postwar Heating and Air Conditioning of Railroad Cars	D. J. Jones, Vapor Car Heating Co.	Mr. Jones stressed the importance of the controls for heating and cooling the cars	80	0.51
	Mar. 12	The Engineered Btu's Effect on Political Forces	Brig.-Gen. W. A. Danielson, Memphis, Tenn.	John Howatt and General McCloskey offered interesting comments. Life Membership Certificate was presented to Carl W. Johnson	62	0.39
Iowa	Mar. 13	Radiant Heating with Hot Water Coils	C. A. Hawk, Jr., A. M. Byers Co., Pittsburgh, Pa.	Slides of actual installations were shown and many questions were answered	39	
Kansas City	Apr. 2	History of Kansas City Chapter	Nate W. Downes, Asst. Supt. in charge of buildings, Kansas City, Mo.	Nominating Committee appointed	48	0.49
		Air Filters	Paul Leffel, Kansas City	Ray Mason reported on Chapter Delegates meeting in Boston		

CHAPTER	MEETING DATE	SUBJECT	SPEAKERS	OTHER FEATURES	ATTENDANCE	ATTENDANCE RATIO*
		Description of Natural Cooler Cave at Atchison, Kans.	D. V. Case, Engrg. Consultant, Shipping and Storage Br., War Food Administration			
Massachusetts	Mar. 20	Kathabar Dehumidifiers	E. A. Windham, Div. Mgr., Surface Combustion		28	0.39
		Combustion Heaters for Aircraft	K. G. Hull, Dist. Mgr., Surface Combustion			
Memphis	Apr. 2	Feed Water Control	H. A. Schleider, Northern Equipment Co., Erie, Pa.	Round table discussion	22	
	Mar. 5	Piping Maintenance	John Mitchell, Industrial Mgr., Crane Co., Memphis, Tenn.	Walker Wellford, Jr., chairman of Nominating Committee, submitted his report	20	0.80
Minnesota	Apr. 7	Engineered Air Distribution (illustrated with slides)	V. M. Lathers, Barber-Colman Co., Rockford, Ill.	O. L. Lilla, chairman of Entertainment Committee, reported	64	
Montreal	Mar. 19	Discussion on Funds Available for Research Work in Canada	Messrs. Madden, Salter, Ballantyne, MacDermot, Worthington, Becker, Moore, Murray, Monahan, Peart, Flanagan, Colford, Phillips, and Garneau entered into discussion	Considerable discussion throughout entire meeting A research committee was appointed	30	0.30
New York	Apr. 16	Conduit System of Air Conditioning	M. J. Wilson, Engr., Carrier Corp., Syracuse, N. Y.	H. S. Johnson was commended for the excellent work of his committee Board of Tellers announced election of officers	150	0.65
	Mar. 19	Industrial Ventilation and Hygiene	Arthur C. Stern, Chief Engr., Div. of Industrial Hygiene, New York Dept. of Labor	A question and answer period followed	60	0.26
North Texas	Mar. 19	Dallas' Water System, Present and Future	Homer A. Hunter, Supt., Dallas City Water Works	Pres. Gessell appointed Messrs. Vinther, McClanahan, Young, Pines, Allison and Avera to study Senate Bill 226, concerning licensing of contractors of warm air heating, air conditioning, etc.	36	0.75
Northern Ohio	Mar. 12	Psychrometric Instruments	L. G. Seigel, Instructor, Case School of Applied Science, Cleveland, Ohio	Discussion followed John James reported for Membership Committee	54	0.44
		Air Dehydration-Past, Present and Future	Ed. Schultz	Question and Answer period followed		
Ontario	Apr. 9	Panel Discussion Fuels and Their Future	H. H. Angus, Chairman, assisted by Messrs. J. R. Frith, Toronto, W. C. Leitch, Springfield, Mass., and D. K. Smith, Rochester, N. Y.	Coal, oil and gas were discussed J. P. Fitzsimons introduced all new members who joined during past year	127	0.54

CHAPTER	MEETING DATE	SUBJECT	SPEAKERS	OTHER FEATURES	ATTENDANCE	ATTENDANCE RATIO*
Oregon	Mar. 8	Tomorrow's View of Heating Design	M. I. Levy, Pres., Viking Air Conditioning Corp., Cleveland, Ohio	The secretary cast the ballot for officers for coming year	24	
Pacific Northwest	Mar. 13	Earth Movers	Sound movie depicting enormous problems confronting the engineers in the war zones	Foster Pratt, former chapter president, now located in Washington, D. C., gave interesting discussion on various phases of his work in Washington	28	0.43
		Here is China	Sound film showing vast problems encountered in the immediate future and at the war's end			
Philadelphia	Mar. 9	Manufacture, Uses and Possibilities of Plastics	Al Redles	J. H. Hucker, chairman of Nominating Committee, presented the slate of officers	65	0.39
Pittsburgh	Apr. 9	The Principles and Experiences of Reverse Refrigeration for Heating	L. Gale Huggins, Asst. Mgr., Air Conditioning Div., Westinghouse Electric Elevator Co.	Nominations for officers submitted J. F. Collins reported on work of Constitution Committee; also read a Resolution for Comdr. F. C. Houghten	104	0.47
	Mar. 12	Postwar Foods	Dr. F. C. Blanck, Chief Research Chemist, H. J. Heinz Co., Pittsburgh, Pa.	Interesting discussion followed	69	0.54
Rocky Mountain	Mar. 7	Special Meeting (ladies and guests)	G. D. Maves, chairman of Program Committee, assisted by Messrs. McEahern and Hook, arranged the entertainment	L. C. McClanahan, Pres. of North Texas Chapter, was among the guests	54	1.06
St. Louis	Mar. 6	Aims and Activities of NWAH ACA	George Boeddener, Secretary, National Warm Air Heating and Air Conditioning Assn.	Nominating Committee was appointed	93	1.43
Southern California	Mar. 14	Problems in Air Conditioning Motion Picture Studios and Laboratories	John L. Blake, Chief Engr., Air Conditioning Div., Metro-Goldwyn-Mayer Studios	He reviewed many of the problems of the postwar period	53	0.69
Utah	Apr. 4	Fuel Conservation	Howard J. Hassel	The enthusiastic reception was indicative of the interesting and informative address	18	0.63
	Mar. 7	Use of Powdered Coal, as Applied to the Larger Commercial and Industrial Heating Plants	C. H. Spencer, Sales and Service Supvr., Stokermatic Co., Salt Lake City	Illustrated his talk with many interesting colored shots of interior of furnaces from various angles	30	0.75
Washington, D. C.	Apr. 5	The Road to Postwar Prosperity	Dr. Charles Copeland Smith, National Association of Manufacturers	The Nominating Committee submitted its report	140	0.55
	Mar. 14	The Air-Cooled Human Body	Dr. C.-E. A. Winslow, Pres. of ASHVE, New Haven, Conn.	Brig.-Gen. W. A. Danielson, Memphis, was also a guest	81	0.38
Western Michigan	Apr. 9	Conduit Weathermaster System	H. C. Hoffman, Carrier Corp., Syracuse, N. Y.	W. G. Schlichting reported as chairman of Nominating Committee	55	0.79

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*The attendance ratios shown represent the meeting attendance divided by the Chapter membership. These will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by other local chapters and may be helpful in deciding on subjects for other chapter meetings.

Candidates for Membership

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the Journal of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 80 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by May 16, 1945, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
ALEXANDER, JOHN W., Mech. Engr., Public Buildings Administration, Washington, D. C.	C. R. Kidd H. H. Koster	R. Skagerberg G. R. Walz
ALLEN, A. B., Office Mgr., Oil Burning Engineers, Inc., Chicago, Ill.	C. W. DeLand E. N. McDonnell	C. W. Johnson N. W. Swanson
BAKER, EDWARD L., Mgr., Burbidge Coal Co., Salt Lake City, Utah.	H. G. Richardson E. V. Gritton	D. R. Wilde D. B. Holford
BIRNER, IRA L., Mgr., Tech. Sales & Service Dept., The Celotex Corp., Chicago, Ill.	P. D. Close Wallace Waterfall	R. E. Hattis J. H. Bracken
BOWIE, ROBERT, Mgr., Engrg. Dept., H. G. Skelton & Co., Capetown, South Africa.	Jacob Ehlers Robert Caldwell	
BUGHER, GEORGE A., Owner, Bugher Metal Products Co., Houston, Texas.	C. L. Boehler J. A. Walsh	D. S. Cooper J. C. Lewis
BUTTERWORTH, THOMAS E., Sales Engr., Owens-Corning Fiberglas Corp., Cleveland, Ohio.	Joseph Wilhelm C. W. Maple	J. M. Black Dennis Boggs
CAMPBELL, G. C., Sr. Partner, Campbell-Elsey Co., Salt Lake City, Utah.	R. C. Brown A. A. Maycock	D. B. Holford E. V. Gritton
CANTERBURY, HOWARD M., Repr., J. A. Walsh & Co., Inc., Houston, Texas.	C. L. Boehler J. A. Walsh	J. C. Lewis D. S. Cooper
CHANG, JOHN H., Student Engr., Carrier Corp., Syracuse, N. Y. N. Y.	W. G. Hillen J. H. Carpenter	R. E. Cherne W. A. Grant
CHAR, RAGHAV D., Owner, Industrial & Agricultural Engineering Co., Bombay, India.	H. W. Pound John Hellstrom	W. L. Gabbert H. C. Murphy
COHEN, MILTON L., Student Engr., Carrier Corp., Syracuse, N. Y.	W. G. Hillen J. H. Carpenter	R. E. Cherne W. A. Grant
COOK, RUSSELL M., N. Y. Sales Mgr., Taco Heaters, Inc., New York, N. Y.	J. R. Murphy R. E. Daly	E. T. Houlihan L. N. Hunter
CRAIG, WILLIAM G., Asst. Sales Mgr., AiResearch Manufacturing Co., Los Angeles, Calif.	J. S. Earhart R. S. Farr	W. S. Kilpatrick J. F. Park
CRAWFORD, EDWARD F., Owner, M. B. Crawford & Son, Oswego, N. Y.	V. C. Page H. L. Mohn	R. T. Demarest R. C. Malvin
CRAWFORD, FRED A., Owner, Home Comfort Heating Co., Detroit, Mich.	F. R. Bishop E. B. Root	W. O. Smith M. B. Shea
CURTIS, A. RAY, Owner & Mgr., A. Ray Curtis Co., Salt Lake City, Utah.	E. V. Gritton H. G. Richardson	E. J. Watts D. R. Wilde
DAVIS, LEONARD V., Research & Design Engr., Russell Stovers Candy Co., Denver, Colo.	J. E. McNevin F. L. Adams	C. B. Ward G. D. Maves
DAY, SIDNEY S., Owner, Sidney S. Day Heating, Portland, Ore.	A. E. Finlay E. C. Willey	G. H. Risley T. E. Taylor
DEAN, VERNON C., Cons. Engr., Grand Rapids, Mich.	F. C. Warren H. D. Bratt	L. A. Calcaterra O. D. Marshall
DOLGE, EMIL A., Mgr., Htg. Dept., A. Y. McDonald Manufacturing Co., Des Moines, Iowa.	C. H. McGuiness T. R. Johnson	D. E. Wells F. E. Triggs
DUTTON, GAYLE R., Partner, Western Fiberglas Supply, Ltd., San Francisco, Calif.	J. O. Martin James Gayner	H. R. Scandrett N. H. Peterson
EAVES, MELVIN S., Sales Engr., Johnson Service Co., Atlanta, Ga.	C. L. Templin Leo Sudderth, Jr.	J. M. Rittelmeyer C. B. Smoot
FENN, CHARLES V., Dist. Mgr., Carrier Corp., Atlanta, Ga.	E. R. Foss L. F. Lawrence, Jr.	A. H. Koch R. S. Arnold
GOODE, A. E., Mech. Engr. & Draftsman, Robert & Co., Inc., Atlanta, Ga.	W. J. McKinney W. W. Carder	R. F. Hahn E. T. Gorbandt
GRAVES, CHARLES S., Asst. Steam Heat & Water Service Engr., A. T. & S. F. Ry. Co., Topeka, Kans.	R. B. Mason D. M. Allen	H. C. Smith W. E. White
GREEN, DONALD P., Supt., John E. Green Plumbing & Heating Co., Inc., Huntington Woods, Mich.	R. D. Randall R. H. Oberschulte	W. H. Old M. B. Shea
HOFFMAN, CARL J., Branch Engr., Frigidaire Div., General Motors Corp., Chicago, Ill.	R. E. Hattis E. H. Wendt	J. F. Cummiskey J. S. Locke
HOFFMAN, CHARLES F., Mech. Engr., Bellman, Gillett & Richards, Toledo, Ohio. (*Reinstatement & Advancement.*)	S. R. Lewis A. L. Vanderhoof	H. F. Randolph R. D. Randall

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*Non-member.

JACKSON, MELVIN W., Pres., Dallas Engineering Co., Dallas, Texas.	John Ray D. C. Pfeiffer	J. P. Ashcraft V. G. Cox
JAFFKE, WALTER W., Asst. Buyer, Nelson Co., Detroit, Mich.	W. H. Old A. E. Knibb	M. B. Shea W. G. Boales
JANES, THOMAS J., Mech. & Elec. Engr., University of California, Berkeley, Calif.	G. M. Simonson C. E. Bentley	E. H. Goins D. I. Murphy
KELLEY, DAVIS F., Secy.-Treas., Edwin P. Ambler, Inc., St. Louis, Mo.	B. C. Simons G. B. Rodenheiser	Louis Steckhan W. J. Oonk
KLEIKAMP, HENRY, Mech. Engr., Cory, Joslin & Macnsons, De Soto, Kans.	Gustav Nottberg D. M. Allen	C. L. McMichael M. M. Rivard
KNOX, JOHN R., Branch Mgr., United States Radiator Corp., Pittsburgh, Pa.	T. F. Campbell P. A. Edwards	E. S. Tower W. H. Bateman
KOCHEL, ROBERT K., Htg. & Vent. Engr., Goodyear Aircraft Corp., Akron, Ohio.	D. W. Swenehart D. E. Humphrey	M. P. Erdmann Anthony Kazlouskas
LA ROW, LEO E., Indus. Gas Engr., Central New York Power Corp., Utica, N. Y.	J. W. Stevens G. F. Keane	W. L. Lynch D. D. Wile
LARSH, HERSCHELL J., Owner, Larsh Sheet Metal Works, Indianapolis, Ind.	F. G. Tykle J. E. Clemens	G. B. Supple I. W. Cotton
LEE, LESTER A., Mgr., American Radiator & Standard Sanitary Corp., Detroit, Mich.	A. E. Knibb W. H. Old	M. B. Shea W. G. Boales
MANIER, RALPH L., Indus. Ht. & Air Cond. Engr., Central New York Power Corp., Syracuse, N. Y.	J. W. Stevens G. F. Keane	W. L. Lynch D. D. Wile
MASSAGLIA, P. E. C., Sr. Student, Massachusetts Institute of Technology, Cambridge, Mass.	James Holt G. B. Wilkes	*C. L. Svenson A. L. Hesselschwerdt
MAYCOCK, GEORGE E., Htg. & Vent. Engr., A. A. Maycock Co., Salt Lake City, Utah.	D. B. Holford A. A. Maycock	Alfred Richeda C. E. Murdock
MCCALL, HERBERT M., Owner & Mgr., McCalls, Indiana, Pa.	H. J. Kirkendall A. W. Nash	E. H. Riesmeyer, Jr. *A. K. Tinker
MCKINSTRY, MERRILL W., Supt., W. E. Beggs Co., Seattle, Wash.	E. H. Langdon K. H. Norby	J. H. Faulkner H. E. Lusk
MICHAEL, ARTHUR F., Gen. Supvsr. of Air Cond., Southern California Gas Co., Los Angeles, Calif.	Leo Hungerford Art Theobald	R. A. Lowe Maron Kennedy
MOUNTFORD, RALPH E., Tech. Consultant, Ministry of Supply, London, England.	*S. G. Trimmer	W. G. Case G. E. Smith
NELSON RAYMOND A., U. S. Air Conditioning Corp., Minneapolis, Minn.	L. P. Hanson A. E. Bauer	Lyman Gross C. A. Schad
O'DANIEL, PRESLEY, Branch Mgr., York Corp., Memphis, Tenn.	R. H. Hoshall R. C. Smith	W. E. Thorpe J. D. Flinn
OSTERMEIER, EDWIN J., Director of Engrg., Apex All-Weather Products Co., Chicago, Ill.	J. S. Locke C. E. Price	C. M. Burnam, Jr. O. J. Prentice
PEACOCK, WILLIAM H., Mgr., Peacock Plumbing & Heating, Kitchener, Ont., Canada.	R. M. Bayles T. H. McLaren	E. R. Gauley V. J. Jenkinson
PETRONIS, ALBERT, Student Engr., Carrier Corp., Chicago, Ill.	W. G. Hillen J. H. Carpenter	R. E. Cherne Margaret Ingels
PFEIFFER, GEORGE R., Estimator, Harrigan & Reid Co., Detroit, Mich.	E. M. Harrigan W. J. Whelan	F. J. Scherger G. H. Tuttle
POOLE, JOE A., Office Engr., Associated Mechanical Contractors, Camden, Ark.	C. L. Kribs, Jr. D. E. Beals	T. H. Anspacher M. L. Brown
PORTE, CLIFF E., Mgr., W. A. Case & Son Manufacturing Co., Detroit, Mich.	M. B. Shea W. H. Old	R. L. Deppmann L. A. Burch
PORTER, ELLIS A., Owner, E. A. Porter Co., North Syracuse, N. Y.	J. W. Stevens G. F. Keane	W. L. Lynch D. D. Wile
PULTE, JOHN W., Mfr. Agent, J. W. Pulte Co., Grand Rapids, Mich.	W. W. Bradfield T. L. Osberger	F. C. Warren L. A. Calcaterra
ROBINSON, FREDERIC W., Director of Research, Hanovia Chemical & Manufacturing Co., Newark, N. J.	W. F. Wells C. F. Roth	Donald French T. H. Munkelt
SALEVA, GUSTAVO, Pres., Electrica-Commercial, Inc., San Juan, Puerto Rico.	Frederick Boxall J. M. Brown	*H. E. Wood *O. B. Wert
SCHARMER, GEORGE A., Sheetmetal Worker, U. S. Navy Department, Bayonne, N. J.	*E. C. Soares *J. Suda	*G. A. Belsky A. Esposito
SEITZ, RALPH C., Central New York Power Corp., Syracuse, N. Y.	J. W. Stevens G. F. Keane	W. L. Lynch D. D. Wile
SLATER, WILLIAM H., Student Engr., Carrier Corp., Syracuse, N. Y.	W. G. Hillen J. H. Carpenter	R. E. Cherne Margaret Ingels
SNOW, EDWARD E., Chief Designer & Engr., Mellor Bromley & Co., Ltd., Leicester, England.	T. H. Gouldbourne J. J. Fraser	*H. P. Pulsford *A. Mayall
STANGER, WILLIAM F., Sales Engr., Robinson & Stanger, Pittsburgh, Pa.	C. M. Humphreys F. C. McIntosh	R. B. Stanger E. C. Smyers
SWASKI, KENNETH J., Co.-Owner, Swaski Refrigeration Service, Albany, Oregon.	*R. A. Twiss *Dewy Oakes	*J. B. Hieber *Mary Cardey
SWENBERG, WALTER A., Chief Quarterman, United States Naval Drydocks, Terminal Island, Calif.	H. M. Hendrickson Maron Kennedy	*W. J. Ross *H. R. Little
THOMPSON, ROLAND J., Engr., Bureau of Ships, Navy Department, Washington, D. C.	A. S. Gates, Jr. C. W. Porter	C. M. Hamblin J. G. Muirheid
TOWNE, ROBIN M., Heating Service Co., Seattle, Wash.	W. W. Cox E. O. Eastwood	E. H. Langdon S. D. Peterson
TRAMBAUER, CHARLES W., Supervising Engr., Raisler Corp., New York, N. Y. (*Advancement*).	W. M. Heebner C. S. Koehler	C. W. Stewart E. N. Sanbern
TURNBULL, FRANCIS J., Staff Member, Massachusetts Institute of Technology, Cambridge, Mass.	James Holt F. D. B. Ingalls	E. G. Carrier J. W. Brinton
VANDAMENT, DAN D., Mech. Engr., Navy Public Works Dept., Treasure Island.	N. H. Peterson K. O. Alexander	H. V. Hickman E. H. Goins
VAN WEELDEN, MORRIS J., Mech. Engr., Illinois Bell Telephone Co., Chicago, Ill.	J. J. Philippi O. G. Ward	M. F. Mattingly J. E. McClellan
WENDT, W. R., JR., Student & Research Apprentice, Dept. of Mech. Engrg., University of Wisconsin, Madison, Wis.	G. L. Larson D. W. Nelson	*B. G. Elliott *L. H. Wilson
WERLEY, WILLIAM C., Peerless Fory Co., St. Louis, Mo.	L. A. McMahon B. C. Simons	J. F. Naylor, Jr. W. J. Oonk

Westphal, Edward R., Mgr. of Plants, Weil-McLain Co., Michigan City, Ind.	W. R. Stockwell C. F. Newport	O. G. Ward J. J. Philippi
Wilkes, Floyd, Sales Engr., Westerlin & Campbell Co., St. Paul, Minn.	E. J. Uhl F. W. Legler	A. B. Algren W. F. Uhl
Wilson, Harry F., Cons. Engr., St. Louis, Mo.	George Myers J. W. Cooper	E. E. Carlson C. R. Davis
Woffenden, Harold, Cons. Engr., "The Birches" Wood Green, N. R. Fording Bridge, Hants, England.	R. H. Davies T. H. Gouldbourne	*D. Baldwin
Wolf, Robert L., Instructor of Mech. Engrg., Washington University, St. Louis, Mo.	D. J. Fagin George Myers	R. R. Tucker Lester Gross
Wolpert, Nathan N., Assoc. Editor, Heating and Ventilating, New York, N. Y.	Clifford Strock C. H. Flink	F. W. Hutchinson T. W. Reynolds
Woodall, Raymond G., Staff Supvsr., Savannah Machine & Foundry Co., Savannah, Ga.	*J. C. Hickman *Guy Hairston	*A. F. Tuck *J. J. Munroe

Candidates Elected

In the past issues of the Journal of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

Aikin, Aziel A., Plant Engr., Oldsmobile, Lansing, Mich.
Atwater, Harry A., Chief Engr., Combustion Equipment Co., Kansas City, Mo.
Bloom, Ralph L., Mech. Engr., Minneapolis, Minn.
Bueter, Norman E., Acting Dir. of Sales Comfort Air Cond., Carrier Corp., Syracuse, N. Y.
Crisman, Leon J., Owner, Crisman Heating & Air Conditioning Co., Lansing, Mich.
Davis, J. T., Sales Engr., The Trane Co., Houston, Tex.
Givelber, S. H., Reliance Heating & Air Conditioning Co., Cleveland, Ohio (*Reinstatement*)
Gregory, Henry D., Hendrie & Bolthoff Manufacturing & Supply Co., Denver, Colo. (*Advancement*)
Hickey, C. B., Sales Engr., Hendrie & Bolthoff Manufacturing & Supply Co., Denver, Colo. (*Advancement*)
Kinzer, Osborn A., Capt., Corps of Engineers, U. S. Army, Chief Heating Unit, Hq. Ninth Service Command, Ft. Douglas, Utah.
Layton, J. William, Chief Engr., Propellair Inc., Springfield, Ohio.
Lett, Max A., Mech. Engr., Grand Rapids, Mich.
Mac Gann, Lloyd G., Engr., Minneapolis-Honeywell Regulator Co., Boston, Mass.
Marconett, Vernon G., Purchasing Supt., The Farquhar Furnace Co., Wilmington, Ohio. (*Advancement*)
McGrath, William L., Project Engr., Carrier Corp., Syracuse, N. Y.
McIntosh, Robert M., Mech. Engr., Harley-Ellington & Day, Detroit, Mich.
Nystrom, Paul E., Archt. & Partner, Law, Law, Potter & Nystrom, Madison, Wis.
Parmelee, George V., Asst. Prof. of Mech. Engrg., Fenn College, Cleveland, Ohio.
Peyrek, Theodore R., Sales Mgr. & Chief Engr., L. J. Wing Manufacturing Co., New York, N. Y.
Pfeiffer, J. Fred, Plbg. & Htg. Contr., Williamsport, Pa. (*Reinstatement*)
Porter, H. Merwin, Beldon Porter Co., Minneapolis, Minn. (*Reinstatement*)
Rambo, Charles, Owner, Sunbeam Heating & Air Conditioning Co., Columbus, Ga.
Sapp, Charles L., Secy.-Mgr., The Farquhar Furnace Co., Wilmington, Ohio. (*Advancement*)
Sheahan, John A., Chief Htg. Engr., Atlanta Gas Light Co., Atlanta, Ga.
Shields, Roy W., Engr., Samuel R. Lewis, Chicago, Ill.
Smith, Alfred J., Consulting Engr., London, England.
Stimson, De Parx, Application Engr., The Bahnson Co., Winston-Salem, N. C.
Strachan, George W., Project Engr., Dravo Corp., Pittsburgh, Pa. (*Reinstatement*)
Vinther, Percy N., Owner, Zumwalt & Vinther, Dallas, Tex.
Woodruff, Henry S., Prod. Engr., Carrier Corp., Syracuse, N. Y.
Hansen, John S., Testing Engr., Sears Roebuck & Co., Chicago, Ill.
Hart, Winston, W., Jr. Engr., Carrier Corp., Syracuse, N. Y.
Hegele, Richard H., Owner & Mgr., H. W. Hegele Co., Urbana, Ohio.
Holt, Donald R., Pipe Shop Foreman, R.C.A. Victor Div., Camden, N. J.
Janssen, Fred, Engr., Public Service Co. of Colorado, Denver, Colo.
Kalbfleisch, R. F., Jr., Supt. of Bldgs. & Grounds, Board of Education, Glens Falls, N. Y.
King, Roy L., Div. Engr., The Heil Co., Milwaukee, Wis.
Kingsland, Norton W., Publisher, Heating & Sanitary Age—Age Publications, Ltd., Toronto, Ont., Canada.
Lankton, Forest E., Engr., Oldsmobile, Lansing, Mich.
Lathers, Victor M., Mgr., Barber-Colman Co., Rockford, Ill. (*Reinstatement*)
Lee, Boyd J., Owner, B. J. Lee Co., Memphis, Tenn.
Lenz, Alfred W., Partner, Johnson-Lenz Heating & Piping Contractors, Memphis, Tenn.
Mahoney, C. L., Plbg. & Htg. Contractor, Kalamazoo, Mich.
McClintock, Walter C., Dist. Mgr., Reznor Manufacturing Co., Milan, Tenn.
McMaster, Sherman G., Mgr. of Htg. Dept., Richards Manufacturing Co., Grand Rapids, Mich.
Miley, Julian J., Supt., Scott Co., San Francisco, Calif.
Miller, Warren W., Sales Engr., Frigidaire Products of Canada, Leaside, Ont., Canada.
Moltz, Bernard S., Pres., Potomac Sheet Metal Co., Inc., Takoma Park, Md.
Mooney, Bernard P., Owner, Mooneys, Minneapolis, Minn.
Napier, Charles E., Sales Engr., Consolidated Engines & Machinery Co., Ltd., Toronto, Ont., Canada.
Parri, Idwal W., Final Test Engr., Perfex Corp., Milwaukee, Wis.
Phillips, Charles R., Factory Planning Engr., Northern Electric Co., Ltd., Montreal, Que., Canada.
Powell, Leroy D., Owner, L. D. Powell Construction Co., Memphis, Tenn.
Romer, William H., Constr., Engr., J. F. Higgins Heating Co., Providence, R. I.
Sanders, William L., Partner, Midwest Plumbing & Heating Co., Kansas City, Mo.
Shumate, James C., Br. Mgr. & Vice-Pres., Noland Co., Inc., Atlanta, Ga.
Smith, Bernard, Tech. Htg. Advisor, Spirax Manufacturing Co., Ltd., Cheltenham, England.
Smith, Elwyn L., Unit Head, U. S. Engineers' Dept., Corps of Engineers, War Department, Kansas City, Mo.
Smith, Russell B., Co-Partner, Hunter-Prell Co., Battle Creek, Mich.
Sterry, H. Lee, Dir. of Business Research, Carrier Corp., Syracuse, N. Y.
Tierney, L. Foster, Mgr., Mulch Brothers, Hollidaysburg, Pa.
Trickey, George, Sales Engr., Pease Foundry Co., Ltd., Toronto, Ont., Canada.
Tucker, J. Robert, Engr., United States Testing Co., Inc., Hoboken, N. J.
Whelan, Leo, Chief Engr., Ray Oil Burner Co., New York, N. Y.
White, Arthur A., Managing Dir., Gilbert & Barker Manufacturing Co., Ltd., Toronto, Ont., Canada.

ASSOCIATES

Anderson, Robert V., Lennox Furnace Co., Inc., Syracuse, N. Y.
Anthelm, Fred G., Front Rank Furnace Co., Webster Groves, Mo. (*Reinstatement*)
Bawden, L. A., Asst. Tech. Mgr., Spirax Manufacturing Co., Ltd., Beechmount, Cheltenham, England.
Bovard, Carl A., Engr., Northrup Supply Corp., Johnson City, N. Y.
Burtis, Herbert D., Co-Partner, Hunter-Prell Co., Battle Creek, Mich.
Clark, Arthur E., Engr., Grinnell Co. of Canada, Ltd., Toronto, Ont., Canada.
Dwyer, Patrick, Draftsman, Richard Crittall & Co., Ltd., London, England.
Erickson, Gordon A., Acting Mgr., Wood Conversion Co., St. Paul, Minn.
Ewell, Walter A., Kaiser Engineers, Oakland, Calif.
Forrester, Charles O., Mech. Engr., Federal Public Housing Authority, Atlanta, Ga.
Fox, Francis J., Supvsr. of House Heat Testing, Minneapolis Gas Light Co., Minneapolis, Minn.
Gaulin, Richard P., Mech. Engr., Federal Public Housing Authority, Washington, D. C. (*Reinstatement*)
Gelert, C., Owner, C. R. Gelert Co., Los Angeles, Calif.

JUNIORS

Clemins, Richard J., Student Engr., Carrier Corp., Syracuse, N. Y.
Johnson, Hugh F., Student Engr., Carrier Corp., Syracuse, N. Y.
Leveridge, Robert H., Student Engr., Carrier Corp., Syracuse, N. Y.
Moran, Edward V., Jr., Student Engr., Carrier Corp., Syracuse, N. Y.
Ramseaur, William S., Develop. Engr., Carrier Corp., Syracuse, N. Y.
Reh, Herbert C., Supvr., Air-Conditioning Utilities Co., Brooklyn, N. Y.
Teverbaugh, Jack E., Student Engr., Carrier Corp., Syracuse, N. Y.
Walsh, Gerald W., Jr., Test Engr., Carrier Corp., Syracuse, N. Y.
Williams, Edgar H., Student Engr., Carrier Corp., Syracuse, N. Y.

PERRY WEST'S DEATH ANNOUNCED

At the age of 66, Prof. Perry West, of the University of Kentucky, died at his home on April 3, at Nicholasville, Ky., after an illness of three months. Perry West was widely known to members of the Society because of his many important contributions, possibly the most important of which was the idea of publishing THE GUIDE, which has become the leading reference volume on heating, ventilating and air conditioning, and which has received world wide recognition.

Professor West's work on various technical committees and as Treasurer of the Society makes an impressive record.

He was born in Nicholasville on December 2, 1878, was educated in the High School of Greenville, Miss., and attended the University of Kentucky, Lexington, from which he received his B.M.E. in 1901 and his M.E. in 1904.

He started his engineering career with Jos. McWilliams & Co., Louisville, Ky., and then went with Pattison Bros., New York, as mechanical engineer in charge of design for the Flatiron Bldg. He next served as mechanical engineer for the New York Edison Co., and he then became superintendent of power plant work for W. S. Barstow & Co., New York. For many years he was mechanical engineer for the Board of Education of Newark, N. J. Professor West then established his own business as consulting engineer in 1924 and his work covered heating, ventilating, electrical, plumbing and elevator equipment for schools, public buildings, and industrial plants. He was responsible for the mechanical equipment in plants of the Johns-Manville Co., National Lead Co., Reynolds Metals Co., Victor Talking Machine Co., and many other important concerns.

In 1935 he supervised the installation of the central heating plant of the University of Kentucky, and in 1937 he joined the faculty of the Engineering School at the University.

Perry West

Professor West was a Life Member of the Society. He joined in 1910 and was active in the work of the New York Chapter, and served as its president in 1918-1919, and on many of its committees.

It was Professor West who conceived the idea of THE GUIDE, and he was the first chairman of the Guide Publication Committee in 1922. As chairman of the Society's Publication Committee in 1921, Professor West developed the plan for the publication of THE GUIDE, and his report contained the following comment:

"... No pains will be spared in making this the last word among publications of this kind and by keeping it confined to this one particular line it is felt that it can be made to show a great improvement over anything of a similar nature yet produced. Aside from this it will contain a number of entirely new and highly useful features and altogether be of the greatest credit and value to our profession. From all indications it promises to be a splendid success as far as subscriptions and listings are concerned, but we wish to ask that each and every member of this Society be careful to see that no lack of interest or support on his part shall be responsible for detracting in the least way from the fullest measure of success for an undertaking of such far reaching importance to us all. This undertaking is a bold one—involving a cost of some $10,000. The reward is correspondingly large, however, for besides the great and general usefulness of THE GUIDE, which goes without question, it will net the Society a splendid income for use in expanding its activities."

Professor West also served on a history making committee in 1917 when he was appointed on the Committee to Investigate the Possibility of Establishing a Research Bureau. Because of the absence of George W. Barr, who was in the Army, Professor West acted as chairman and presented a report at the Annual Meeting in January 1918, which resulted in the establishment of the Society's Research Laboratory.

He served as Vice-Chairman of the first Committee on Research and was Vice-Chairman again in 1932. He was a member of the Committee on Research from 1917-1923, 1925-1927, and from 1931 to 1935.

At the time of the establishment of the Research Committee, Professor West wrote:

"Our functions should, of course, extend to the organization and coordination of manufacturers, medical men and the users of heating and ventilating apparatus in their respective proper relations to the production of proper results. Now, as to just what we should first undertake: I have a very decided opinion that this should embody those things which are of the most vital importance to the welfare of humanity. I would name these in the order of their importance as follows:

"1. The determination of the best methods for defining and maintaining the best heating and ventilating conditions in homes, public buildings and factories.

"2. Determination which would tend to place some of our most commonly used methods of heating and ventilating, such as the furnace system, on a more scientific basis.

"3. A determination of more scientific methods for meeting some of our unusual heating and ventilation conditions, such as those connected with the modern tall office buildings, the modern large factory buildings and buildings requiring intermittent service, as compared with those requiring continuous service.

"4. The determination of a more scientific basis for the standard factors connected with the art of heating and ventilating, such as the heat loss through various building materials, efficiency of various kinds of radiation under various conditions of use, the pipe size factors for different types of heating systems, determination factors for air ducts and standard methods of testing and comparing the performance of heating and ventilating systems with the proper results to be attained."

Professor West served on the Council of the Society in 1920-1922 and 1925, and as Treasurer in 1924-1925. Among the numerous committees on which he served were the following: Chapter Relationship in 1920; Code of Ethics in 1921-22; Synthetic Air Chart in 1922; Committee to Consider the Report of the New York State Commission on Ventilation in 1923; Standards of Ventilation in 1924-1926 and from 1932-1935; Code for Minimum Requirements for the Heating and Ventilation of Buildings in 1930; and the Technical

Advisory Committees on Heat Transmission in 1929; Correlating Thermal Research 1931-32 and in 1934; Minimum Temperature and Method of Introduction of Cooling Air in Classrooms in 1934-35; and the Committee on Atmospheric Dust and Air Cleaning Devices in 1932.

Professor West is survived by his widow, Mrs. Mary Buford West, Nicholasville; his father, T. E. West; two sisters, Mrs. Lula McConathy and Mrs. C. L. Cosby, both of Lexington; a brother, Howard West, White Plains, N. Y., and an uncle, Henry Perry, Nicholasville, Ky.

The Officers and Council feel keenly the great loss that the Society has suffered in the untimely passing of Professor West, and they know his many friends join them in an expression of sincerest sympathy to his family.

JOHN H. KITCHEN DIES AT 75

One of the Society's Life Members, John H. Kitchen, Kansas City, Mo., died on April 9, after an illness of two months at his home at the age of 75.

Mr. Kitchen was engaged in the field of heating and ventilating for over 50 years and was responsible for many installations in schools, churches, public buildings, and factories in the south and southwest.

He was born in Easton, Pa., April 6, 1870, and was graduated from Toledo University in 1887. His first business experience was with J. D. Smead Heating and Ventilating Co., Toledo. He was an organizer of the firm of Lewis and Kitchen, consulting engineers, and in 1913 the firm name was changed to the John H. Kitchen Co.

During his 50 years in the field he was responsible for the installation of mechanical equipment in many public buildings and had the distinction of doing the engineering installations in nearly 1000 schools and public buildings in the southwest. During this war period he had specialized in the design and installation of plants in aircraft hangars and buildings.

Mr. Kitchen played a leading role in the organization of the Kansas City Chapter of the Society and served as its secretary from 1916-1920, and then as its president in 1920-1921. He joined the Society in 1906 and served on a great many of its committees, including the Committee on Testing Furnaces 1918-1922, Committee on Chapter Relationship in 1920, Nominating Committee in 1925, and the Technical Advisory Committee on Intermittent Heating in 1936-1937.

John H. Kitchen

He was a vice-president and director of the Chamber of Commerce of Kansas City, a member of the Sons of the American Revolution, and had been an active member of the Westminster Congregational Church for the past 35 years.

When acknowledging his Life Membership, Mr. Kitchen said:

> "It hardly seems possible that over thirty years have elapsed since I joined the Society, but the records so show. During that period tremendous strides have been made and the future holds promise of even more progress.
>
> "It has always been a pleasure and source of satisfaction to contribute toward the upbuilding of the Society and particularly to its membership. Valuable information is obtainable from THE GUIDE. The research work is of great value. The management of the Society is fine. Therefore, in every sense of the word the ASHVE is a 'going concern.'
>
> "The point I have always made with prospective members is that the Society is the clearing house for all worthwhile work in our line. You will find by the record that many members have been induced to join because I could truthfully assure them of the above."

The Officers and Council extend their sincere sympathy to his family, his widow, Mrs. Mabel L. Kitchen, Kansas City; two sons, Lewis E. Kitchen, Kansas City, Francis A. Kitchen, Cleveland; a daughter, Mrs. E. G. O'Neill, Newburgh, N. Y.; three sisters, Mrs. Samuel R. Lewis, Chicago; Mrs. Hugh C. Ross and Miss Louise Kitchen, both of Toledo, Ohio; and three grandchildren.

R. E. PURCELL DIES IN DETROIT

Robert E. Purcell passed away on March 25, at the age of 56. He was born in Wyandotte, Mich., March 22, 1889, and served as an apprentice with Harrigan and Reid, Detroit.

He later entered business for himself as an engineer and contractor for heating, ventilating and sanitary work. For the past seven years he was connected with Davis Bros., Inc., Detroit, as sales engineer and estimator.

Mr. Purcell first joined the Society in 1916 and was very active in the Michigan Chapter activities.

He is survived by his widow, to whom the Officers and Council of the Society extend their sincere sympathy.

SAMUEL G. NEILER DIES IN CHICAGO

Word of the death of Samuel Graham Neiler, Life Member of the Society, has been received. Mr. Neiler passed away at his home, 737 N. Oak Park Ave., Oak Park, Ill., on February 28, 1945, after spending fifty years in the consulting engineering field.

Mr. Neiler was born in Erie, Pa., on November 14, 1866, and attended public schools in Minneapolis, Minn. He attended the Massachusetts Institute of Technology and took a special engineering course at the University of Minnesota from 1886 to 1889.

He started his engineering career in Minneapolis in 1889 with the Minneapolis, St. Paul and Sault Ste. Marie Railway and later joined Thomson - Houston Electric Co., Lynn, Mass. He went to Chicago in 1892 as assistant electrical engineer at the World's Columbian Exposition. In 1895 he became a member of the Consulting Engineering firm of Pierce, Richardson and Neiler, which in later years was succeeded in turn by Neiler, Rich and Co., and Neiler, Rich and Bladen, in which at the time of his death he was the senior partner.

During these years many large and important mechanical and electrical projects in the middle west were carried on under his direction, notably in Chicago, Northwestern Railroad Station, University of Chicago steam and electric development, and work on many buildings for both Chicago and Northwestern Universities and others of similar character. During the past war years his entire organization was turned over to the architectural and engineering firm of Fugard, Olsen, Urbain and Neiler, of which he was a member and which successfully completed the design of a number of large construction projects for both the Army and the Navy.

Mr. Neiler joined the Society in 1898 and was elected to Life Membership in 1936. He served as a member of the Committee on Tests 1906-1907 and as a member of the Committee on Increase of Membership in 1921, and took an active part in the affairs of the Illinois Chapter. He also held life membership in the American Institute of Electrical Engineers and the American Society of Mechanical Engineers and memberships in the American Society of Civil Engineers and other societies of similar character.

The officers and Council of the American Society of Heating and Ventilating Engineers extend their sincere sympathy to his family.

TRIBUTES TO TWO PHILADELPHIA MEMBERS

At its April meeting the Philadelphia Chapter adopted resolutions of condolence on two of its recently departed members as prepared by a special committee, H. B. Hedges, W. P. Culbert and M. F. Blankin:

K. C. S. Jacobsen

It is with deep regret that the Philadelphia Chapter of the American Society of Heating and Ventilating Engineers records the passing of one of their active members, K. C. S. Jacobsen, who died suddenly at his home on March 13, 1945.

Mr. Jacobsen was born on December 10, 1882 on the island of Jamaica. He graduated from Victoria College on the Isle of Jersey in the Channel Islands, and received his engineering degree in the Engineering College, Faraday House, London, England.

He came to Canada in 1910 and worked there for the Westinghouse Electric and Manufacturing Company of Canada, spending considerable time in British Columbia. He came to the United States with the General Electric Co. just previous to the last war and represented them in Atlantic City, N. J. He then moved to Philadelphia in 1919, later becoming district manager of the Imperial Electric Co. with whom he was associated for over 20 years. For almost the last 15 years he also acted as district representative for the Baldor Electric Co.

Mr. Jacobsen was a very able and resourceful electrical engineer and concentrated most of his activities with the construction trade, furnishing the complete motor equipment for many of the prominent buildings in the Philadelphia metropolitan area.

He joined the Society in 1939 and was quite constant in his attendance of all of the Chapter meetings. He also attended the 48th Annual Meeting of the Society held in Philadelphia in 1942. He was well known and well liked among his fellow members in the Society and his loss will be keenly felt by his many friends in the heating and ventilating field.

Mr. Jacobsen is survived by his widow, Marie J. Jacobsen, who resides in Philadelphia, and a brother, Scott M. Jacobsen who resides in London, England.

The officers and members of the Philadelphia Chapter of the American Society of Heating and Ventilating Engineers extend their sincerest and heartfelt sympathy to his widow and brother in their great sorrow.

Sidney B. Strouse

The Philadelphia Chapter of the American Society of Heating and Ventilating Engineers have learned with profound sorrow of the passing away on January 23, 1945, of their fellow member, Sidney B. Strouse.

Mr. Strouse was born on February 23, 1883, in Philadelphia, Pa. He attended the Central Manual Training School and later the Engineering School of the University of Pennsylvania.

His first business experience was with the Bell Telephone Co. of Pennsylvania. Later he became a member of the firm of the Pennsylvania Engineering Co. and engineer for the Philadelphia and Western Ice Manufacturing Co., Cardington, Pa. He then spent three years in special studies in physics and advanced mathematics and in 1915 became district manager for Warren Webster Co. at Atlantic City, N. J.

In 1921 he opened up his own office as an electrical and mechanical engineer in Atlantic City, N. J.

Besides being a member of the American Society of Heating and Ventilating Engineers he was also a member of the American Society of Mechanical Engineers. He joined the Philadelphia Chapter of the ASHVE in 1921. While he was not an active member of the Chapter due to the great distance necessary to travel to attend meetings, he nevertheless took a great interest in the Society and contributed from his technical information whenever possible.

He is survived by his widow and one son, Bernard H. Strouse, who was associated with him in business.

The officers and members of the Philadelphia Chapter extend their sincere sympathy to the surviving members of the family.

'FATHER' OF IHVE DIES IN ENGLAND AT 82

The *Institution of Heating and Ventilating Engineers Journal* reports the loss of the Institution's oldest member and the first practicing heating engineer to join its ranks, by the death of Edmund William Mayner.

After managing the office of William Dibben Sons, Ltd., Southampton, he carried on business in Christchurch, Hants, for over 20 years.

Mr. Mayner was a notable local figure, having taken a keen interest in the welfare organizations of his district. Despite his age, he took an active part in Civil Defense duties, and had also acted as chairman of the Publicity Committee for the Christchurch Chamber of Trade, which, before the war, organized the Hospital Carnival.

In 1896, J. Kemsley put forward a proposal to found a society to foster the heating and ventilating trades. Mr. Kemsley was at that time secretary of the Institute of Sanitary Engineers, of which Mr. Mayner was a member of Council. Mr. Mayner approved the suggestion, and when the Institute, as it was then called, was formally constituted in 1897, he joined. Records show that he was probably the first member and the founder-member responsible for introducing the men who filled the office of President during its first few years of existence.

He, however, never occupied the presidential chair, preferring to hold the post of Chairman of an Executive Committee, but it is certain that he recruited Walter Jones, D. M. Nesbit, W. R. Maguire, Louis F. Pearson, and George Crispin, all of whom came to the presidential chair after John Grundy, the first president.

Mr. Mayner celebrated his golden wedding in 1935.

NEW EDITION OF BUILDING INSULATION

A second edition of Building Insulation by Paul D. Close, a member of the ASHVE, and Technical Secretary, Insulation Board Institute, Chicago, has been issued by its publisher, the American Technical Society. A useful feature of the book is the list giving trade names, descriptions and manufacturers of various commercial insulating materials. Conductivities of insulating materials listed by trade names are also given.

Chapters are included on the following subjects: Thermal Building Insulations, Methods of Application, Fundamentals of Heat Transfer Through Building Materials, Transmission Coefficients and Tables, Calculating Heat Losses, Effect of Building Insulation on Heating Plant Size, Fuel Saving, Economics of Insulation, Insulation Efficiencies, Expansion of Roofs, Condensation, Insulation and Comfort, Pipe and Duct Insulation, Sound Insulation, Machinery Isolation, Architectural Acoustics and Noise Quieting, and Questions Pertaining to Building Insulation.

SPECIFICATIONS FOR STEEL PIPING MATERIALS ISSUED BY ASTM

This compilation of ASTM Standards on Steel Piping Materials contains all the specifications for carbon-steel and alloy-steel pipe and tubing issued by the American Society for Testing Materials through the work of its Committee A-1 on Steel (four stainless steel tubing specifications are jointly sponsored with Committee A-10 on Iron-Chromium-Nickel Alloys). The specifications cover material used to convey liquids, vapors, and gases at normal and elevated temperatures; still tubes for refinery service are covered and specifications are included for heat-exchanger and condenser tubes. A number of the widely used standards give requirements for boiler and superheater tubes. To make the volume complete there are also included specifications covering castings, forgings, bolts and nuts used in piping and related installations.

To aid in expediting procurement and in conserving critical and strategic elements, many emergency alternate provisions have been issued. These provisions, printed on colored stock, are incorporated in this book.

The 334-page book of specifications is obtainable from ASTM at 260 S. Broad St., Philadelphia 2, Pa.

ELECTRIC REFRIGERATION—COMMERCIAL STANDARD

The National Bureau of Standards has issued, in printed form, the second edition of Commercial Standard CS 107-45, Commercial Electric-Refrigeration, which supersedes the preceding Standard CS (E) 107-43, Condensing Units.

This Standard becomes effective for new production six months after the cessation of hostilities.

American Society of Heating and Ventilating Engineers

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51 Madison Ave., New York 10, N. Y.
(Tel.: AShland 4-0291)

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Central Ohio: Organized, 1944. Headquarters, Columbus, Ohio. President, J. D. Slemmons, 2 Fifteenth Ave., Columbus 1. Secretary, A. W. Williams, 5 E. Long St., Room 808, Columbus 15.

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Manitoba: Organized, 1935. Headquarters, Winnipeg, Man. Meets, Third Thursday. President, Einar Anderson, 152 Bannerman Ave., Winnipeg. Secretary, F. T. Ball, 324 Main St., Winnipeg.

Massachusetts: Organized, 1912. Headquarters, Boston, Mass. Meets, Third Tuesday. President, D. M. Archer, 143 Federal St., Boston 10. Secretary, A. Ehrenzeller, 23 Parklawn Rd., Boston 32.

Memphis: Organized, 1944. Headquarters, Memphis, Tenn. Meets, First Monday. President, J. J. Nolan, 78 Washington Ave., Memphis. Secretary, W. E. Thorpe, 78 Washington Ave., Memphis.

Michigan: Organized, 1916. Headquarters, Detroit, Mich. Meets, First Monday after 10th of month. President, W. H. Old, 1761 Forest Ave. W., Detroit 8. Secretary, A. E. Knibb, 1003 Maryland Ave., Detroit 30.

Minnesota: Organized, 1918. Headquarters, Minneapolis, Minn. Meets, First Monday. President, F. W. Legler, 17 W. 28th St., Minneapolis. Secretary, F. H. Schernbeck, 1057 10th Ave., S. E., Minneapolis.

Montreal: Organized, 1936. Headquarters, Montreal, Que. Meets, Third Monday. President, A. B. Madden, 1170 Beaver Hall Sq., Montreal, Que. Secretary, Leo Garneau, Room 832, Dominion Sq. Bldg., Montreal, Que.

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New York: Organized, 1911. Headquarters, New York, N. Y. Meets, Third Monday. President, C. S. Koehler, 4374 Richardson Ave., New York 66. Secretary, Carl H. Flink, Room 3000, 51 Madison Ave., New York 10.

North Carolina: Organized, 1939. Headquarters, Durham, N. C. Meets, Quarterly. President, K. W. Selden, Jr., 701 Builders Bldg., Charlotte 2. Secretary, E. S. DeWitt, 1211 Commercial Bank Bldg., Charlotte.

North Texas: Organized, 1938. Headquarters, Dallas, Tex. Meets, Third Monday. President, E. T. Gessel, 610 Thomas Bldg., Dallas 1. Secretary, C. Rollins Gardner, 911 Camp St., Dallas 2.

Northern Ohio: Organized, 1916. Headquarters, Cleveland, Ohio. Meets, Second Monday. President, D. L. Taze, 1302 Swetland Bldg., Cleveland 15. Secretary, R. H. Cutting, 3795 Glenwood Rd., Cleveland Heights.

Oklahoma: Organized, 1935. Headquarters, Oklahoma City, Okla. Meets, Second Monday. President, E. T. P. Ellingson, 314 Savings Bldg., Oklahoma City 2. Secretary, G. T. Donceel, Oklahoma Natural Gas Co., Oklahoma City.

Ontario: Organized, 1922. Headquarters, Toronto, Ont. Meets, First Monday. President, A. S. Morgan, 156 Glenmanor Dr., Toronto, Ont. Secretary, H. R. Roth, 57 Bloor St., W., Toronto, Ont.

Oregon: Organized, 1939. Headquarters, Portland, Ore. Meets, Thursday after First Tuesday. President, F. F. Urban, 6726 S. W. Burlingame Ave., Portland. Secretary, M. W. Pysher, 934 S. E. Sixth Ave., Portland 14.

Pacific Northwest: Organized 1928. Headquarters, Seattle, Wash. Meets, Second Tuesday, President, D. C. Griffin, 717 Lloyd Bldg., Seattle 1. Secretary, C. W. Finn, Boeing Aircraft Co., Plant No. 2.

Philadelphia: Organized, 1916. Headquarters, Philadelphia, Pa. Meets, Second Thursday. President, A. C. Caldwell, 550 S. 48th St., Philadelphia 43. Secretary, J. O. Kirkbride, Fourth and Locust Sts., Philadelphia 6.

Pittsburgh: Organized, 1919. Headquarters, Pittsburgh, Pa. Meets, Second Monday. President, T. F. Rockwell, Carnegie Institute of Technology, Schenley Park, Pittsburgh. Secretary, E. H. Riesmeyer, Jr., 231-33 Water St., Pittsburgh 22.

Rocky Mountain: Organized, 1944. Headquarters, Denver, Colo. Meets, First Wednesday. President, J. H. McCabe, 1730 Glenarm St., Denver. Secretary, F. L. Adams, P. O. Box 840, Denver 1.

St. Louis: Organized, 1918. Headquarters, St. Louis, Mo. Meets, First Tuesday. President, G. B. Rodenheiser, 4431 Finney Ave., St. Louis 13. Secretary, B. L. Evans, 571 Stratford Ave., University City.

South Texas: Organized, 1938. Headquarters, Houston, Tex. Meets, Third Friday. President, A. F. Barnes, 602 Kirby Bldg., Houston 2. Secretary, B. P. Fisher, Box 92, Houston 1.

Southern California: Organized, 1930. Headquarters, Los Angeles, Calif. Meets, Second Wednesday. President, Leo Hungerford, 3485 Wonderview Pl., Los Angeles 28. Secretary, Arthur Theobald, 336 North Foothill Rd., Beverly Hills.

Utah: Organized, 1944. Headquarters, Salt Lake City, Utah. Meets, First Wednesday. President, H. G. Richardson, 1433 Harvard Ave., Salt Lake City. Secretary, E. V. Gritton, 2470 S 15th East St., Salt Lake City.

Washington, D. C.: Organized, 1935. Headquarters, Washington, D. C. Meets, Second Wednesday. President, J. W. Markert, 8506 Garfield St., Bethesda, Md. Secretary, A. S. Gates, Jr., 111 County Rd., Kensington, Md.

Western Michigan: Organized, 1931. Headquarters, Grand Rapids, Mich. Meets, Second Monday. President, H. D. Bratt, 2259 Stafford Ave., S. W., Grand Rapids 7. Secretary, Frank Harbin, Jr., 181 West 21st St., Holland.

Western New York: Organized, 1919. Headquarters, Buffalo, N Y. Meets, Second Monday. President, S. W. Strouse, 493 Franklin St., Buffalo 2. Secretary, G. E. Adema, 39 W. Balcom St., Buffalo.

Wisconsin: Organized, 1922. Headquarters, Milwaukee, Wis. Meets, Third Monday. President, I. J. Haus, 3880 N. Richards St., Milwaukee 1. Secretary, M. W. Bishop, 261 W. Wisconsin Ave., Milwaukee 3.

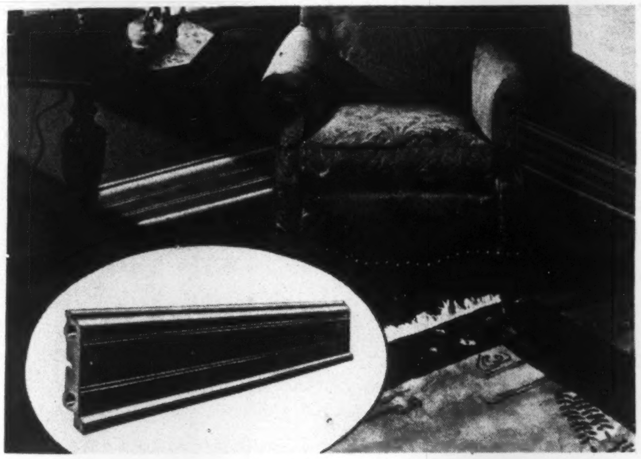
EQUIPMENT DEVELOPMENTS

For your convenience in obtaining more information about any of this equipment, see coupon on this page. Add the new products and companies listed here to your Directory Section which you received in your January 1945 Heating, Piping & Air Conditioning and thus keep your records of sources of supply up to date throughout the year. Single asterisk indicates equipment not listed in Directory Section; double asterisk equipment and manufacturer not listed.

Radiant Heat Panel

No. 2800—A new development in radiant baseboard heating is the "Base-Ray" heat panel, which has been announced by Burnham Boiler Corp., Main St., Irvington, N. Y., for postwar construction and modernization.

This heat panel has been engineered, the manufacturer says, so that it is feasible to heat the average room with a unit that is approximately the same size as the conventional wooden baseboard. The unit is contoured to resemble a typical baseboard and this illusion is heightened by the addition of standard wood moldings at the top and bottom of the panel.



Radiant rays from the heat panel come straight out into the room at ankle height. Tests have shown that in subzero weather the floor to ceiling temperature differential is less than 3 deg.

For installation, sections are joined by means of push nipple construction with short tie bolts. Valves, ells, and traps are connected to the panels at bottom opposite ends, as with tube type radiators. These connections are concealed by a metal enclosure which is flush with the front and top of the panels. The panels will be manufactured in 24 and 12 in. lengths and will be shipped assembled up to approximately 10 ft.

Pressure-Time-Curve Indicator

No. 2801**—The Electro Products Laboratories, Inc., 549 West Randolph St., Chicago 6, Ill., has recently developed the "Pressuregraph," a linear pressure-time-curve indicator.

It is claimed by the manufacturer that this new electronic device will indicate in linear response on the screen of a cathode ray oscillograph the pressure-time curve of any internal combustion engine, pumps, air line, or any other enclosed pressure system where pressure measurements are desired. This device measures either static or dynamic pressures.

In operation, the pickup section of the indicator is inserted in the cylinder, chamber or air line to be pressure measured. The pickup response is transmitted, after amplification, to the screen of a cathode ray oscillograph.

Establishes Air Conditioning Department

No. 2802—Establishment of the air conditioning department as one of the six major operating departments of the General Electric Co. was announced last month by C. E. Wilson, president of the company. Operations pertaining to heating, air conditioning, and commercial refrigeration have previously been the responsibility of the company's appliance and merchandise department. The new department will have its headquarters at Bloomfield, N. J., and George R. Prout has been designated as general manager. He is a graduate of MIT and has been connected with GE since 1920.

The new department will select and utilize appropriate marketing channels and methods for all of its products except air conditioning for rail transportation, which remains a responsibility of the transportation divisions of the company. Sales divisions of the new department are as follows:

The industrial, marine, and contractor equipment division (including refrigerant condensing units and compressors, naval and marine systems, self-contained air conditioners, central plant air conditioners, conditioned air cooling units, finned coil surface and heat transfer assemblies, and evaporative condensers and coolers); the packaged cooling equipment division (including water coolers, room air conditioners, window mounted room coolers, beverage coolers, commercial food storage cabinets, refrigerated merchandisers and dispensers, and frozen food cabinets in large sizes); and the automatic heating equipment division, which is responsible for domestic heating equipment.

Electric Duct Heater

No. 2803—A new "Chromalox" air duct heater, Type

Heating, Piping & Air Conditioning, [5-45]
6 N. Michigan Ave., Chicago 2, Ill.

Please ask the manufacturers to send me more information about the equipment mentioned under the following reference numbers in Equipment Developments and Recent Trade Literature.

(Circle each number in which you are interested)

2800	2801	2802	2803	2804	2805	2806	2807	2808	2809
2810	2811	2812	2813	2814	2815	2816	2817		
4946	4947	4948	4949	4950	4951	4952	4953	4954	4955
4956	4957	4958	4959	4960	4961	4962	4963	4964	4965
4966	4967	4968	4969	4970	4971				

Name .... Title.............

Company ....

Address ....

City.................. Zone........ State..........

Cedars of Lebanon Hospital, Los Angeles, California; Claud Beelman, Architect; Herbert M. Baruch, General Contractor.

REPUBLIC

—THE PREFERRED PIPE FOR HOSPITALS

Whatever the requirements—long service life, freedom from scale, superior fabricating qualities—you will find the answer in Republic Steel Pipe.

Long service life is assured by Republic's improved continuous weld process . . . creating a strong, tight weld that holds even under severe coiling and bending operations. Further protection in galvanized pipe is provided by a tightly adherent, non-flaking coating of corrosion-resistant zinc.

Its uniformly clean surfaces—both inside and outside—are free from valve-clogging scale.

Republic Pipe fabricates freely, too. Because it is uniformly ductile and free from hard spots, it bends and coils easily . . . cuts and threads quickly and cleanly . . . welds readily.

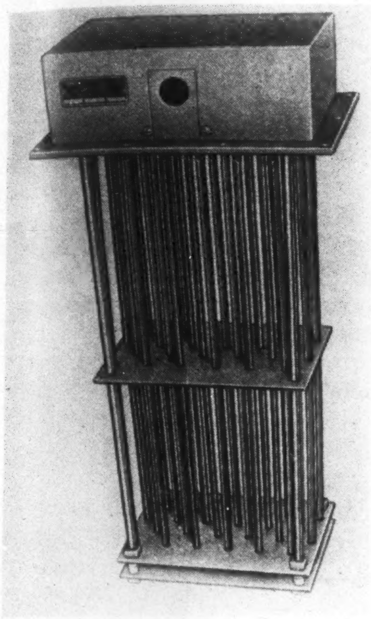
For further information on sizes available and priority required, see your Republic Pipe Jobber. He may have your requirements in stock.

REPUBLIC STEEL CORPORATION
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N. Y.

Republic
STEEL PIPE

Pipe is only one of a wide line of Republic Steel Building Products. See Sweet's for details.

TDH, has been developed by Edwin L. Wiegand Co., 7610 Thomas Blvd., Pittsburgh 8, Pa., for use in high temperature recirculating air systems for air temperatures up to 1050 F maximum. It is made with an assembly of alloy sheathed tubular heaters mounted in an allsteel frame with terminals brought out through a steel flange. The unit is installed in an opening in the air duct and secured by bolting the mounting flange to the outside wall of the duct.

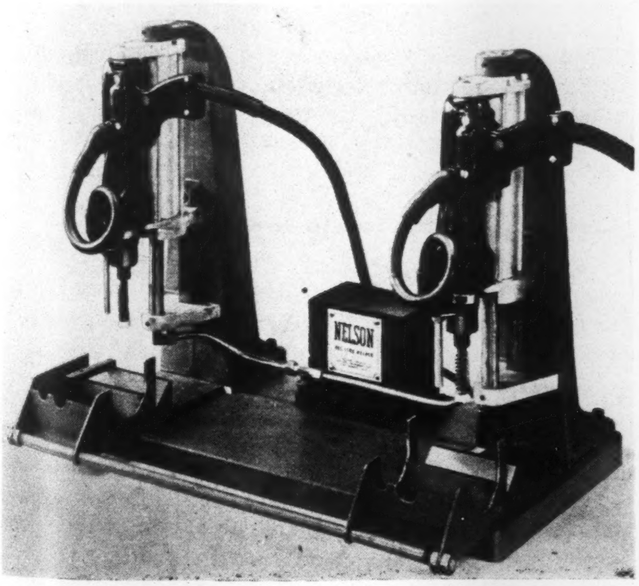


The heated section of elements is located entirely within the air duct while the terminals are located outside, in the cool zone. A steel cover provides against mechanical damage to terminals and eliminates the hazard of exposed electrical connections.

A separately mounted thermostat with a sensitive bulb located close to the heating element provides protection against overheating if the air flow is restricted or accidentally stopped.

Multiple Stud Welder

No. 2804—A new automatic stud welding development to meet mass production requirements is a multiple stud welder production unit. Using this unit two or more studs may be welded in one operation. The work is rapidly performed and the studs are held to very close tolerances, says the manufacturer, Nelson Specialty Welding Equipment Corp., 440 Peralta Ave., San Leandro, Calif.



PRESS and the door pops open!

Save Maintenance Time
with this quick-opening
FLUSH door latch

Hartwell's new *flush* door latch speeds the opening and closing of inspection and access doors. Designed originally for use on combat planes, it meets top specifications for durability and safety.

The Hartwell latch can be used on metal, plastic or wood, and on doors of varying sizes and thicknesses. It can be used on inspection and access doors, cover plates, cabinet and locker doors, and flush fixtures. By eliminating projecting knobs, it improves streamlining; lets you get into narrower spaces.

PRESS to open!
Pressure on the trigger releases the bolt, and the door pops open.

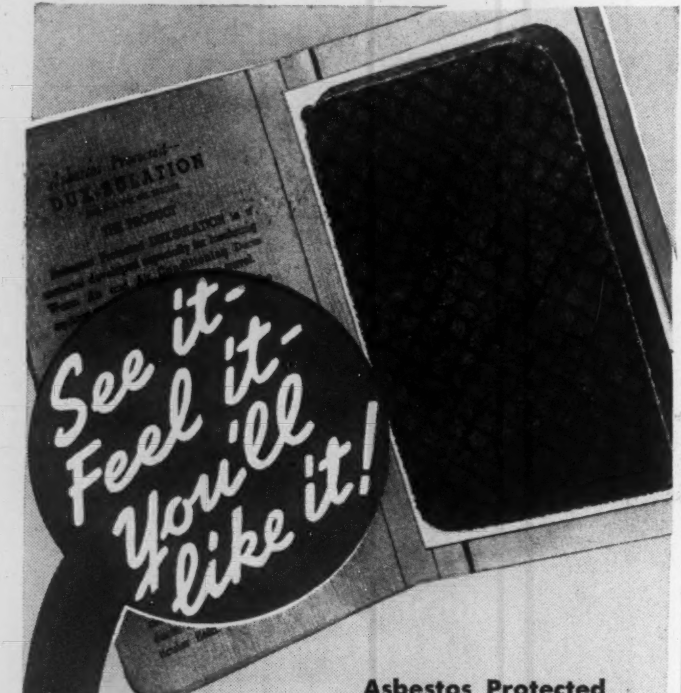
PRESS to lock shut!
Pressure on the bolt, when the door is closed, locks it shut.

Pat. Appl. For

MADE OF STAINLESS STEEL, the Hartwell latch is sturdy and corrosion resistant. Twin springs, controlling bolt and trigger action, insure positive locking. The latch is splash-proof, and can be used with or without the new Hartwell flush hinge. It can be supplied unmounted or spotwelded to an installation plate.

For detailed information about uses and adaptations of the new Hartwell flush door latch, write: Engineering Dept., Hartwell Engineering Company

HARTWELL
ENGINEERING COMPANY
DESIGNERS • MANUFACTURERS • DISTRIBUTORS
3417 Crenshaw Boulevard, Los Angeles 16, California

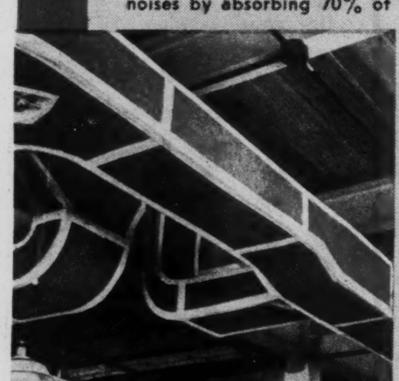


Asbestos Protected

DUX-SULATION

Write for an actual sample of genuine asbestos-protected DUX-SULATION for your inspection and tests. All purpose Dux-Sulation is the nationally accepted Blanket-type insulation for metal Ducts—made especially for the Air Conditioning, Ventilating, and Warm Air industries.

Dux-Sulation does a big job—prevents 75% of your present heat loss, prevents condensation, duct sweating and duct rust. Quiets mechanical and air-borne noises by absorbing 70% of such sound when applied to inside of duct.



Dux-Sulation is a flexible insulating blanket ½" thick having a K. factor .27 B.T.U. Comes complete with corner and joint tape and special adhesive for cementing it on to sheet metal surfaces. Dux-Sulation is 36" wide. A roll contains 100 square feet. Dux-Sulation is easy to apply, easy to handle on the job, and easy to cut and fit.

Asbestos-protected Dux-Sulation is safe. Has low frictional resistance (f=.0001322). Moisture proof surface! Mildew proof treated. Will not chip or flake.

Write us today on your letterhead for our booklet No. 51 containing this attractive actual sample of genuine asbestos-protected Dux-Sulation.

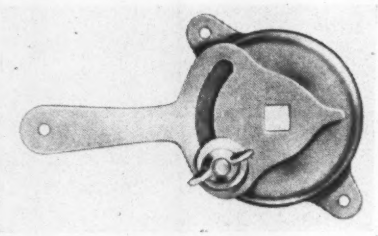
Specify asbestos-protected Dux-Sulation on all your duct work for better performance.

GRANT WILSON, INC.
141 WEST JACKSON BLVD., CHICAGO 4, ILLINOIS

Each of the welding guns is mounted on a pneumatic air cylinder. Each cylinder is fixed to a movable arbor which can be adjusted to any spacing necessary for the work. The work is held in a mandrel, chuck, or special locating device—the setup being determined by the particular production problem at hand. The welding current is obtained from a conventional 400 amp generator, and is regulated by a timing control unit which automatically controls the length of arc flow, producing controlled and consistent welds.

This unit is operated with a single control switch. The work is inserted, the stud is fitted into the chuck of each stud welding gun, and the control switch pressed. The first gun then descends, making a weld. Upon completion of this weld the next gun descends and welds. The guns then ascend automatically and the work is removed.

Damper Quadrant



No. 2805**—A new damper quadrant, designed in modern pattern, has been placed on the market by Western Air Devices, Inc., 1349 E. Vernon Avenue, Los Angeles, Calif. The device comes in ¼ and ⅜ in. sizes and is plated with cadmium. Features claimed for the product are ease of installation, dependability of operation, and ruggedness of construction.

Enlarges Propeller Fan Line

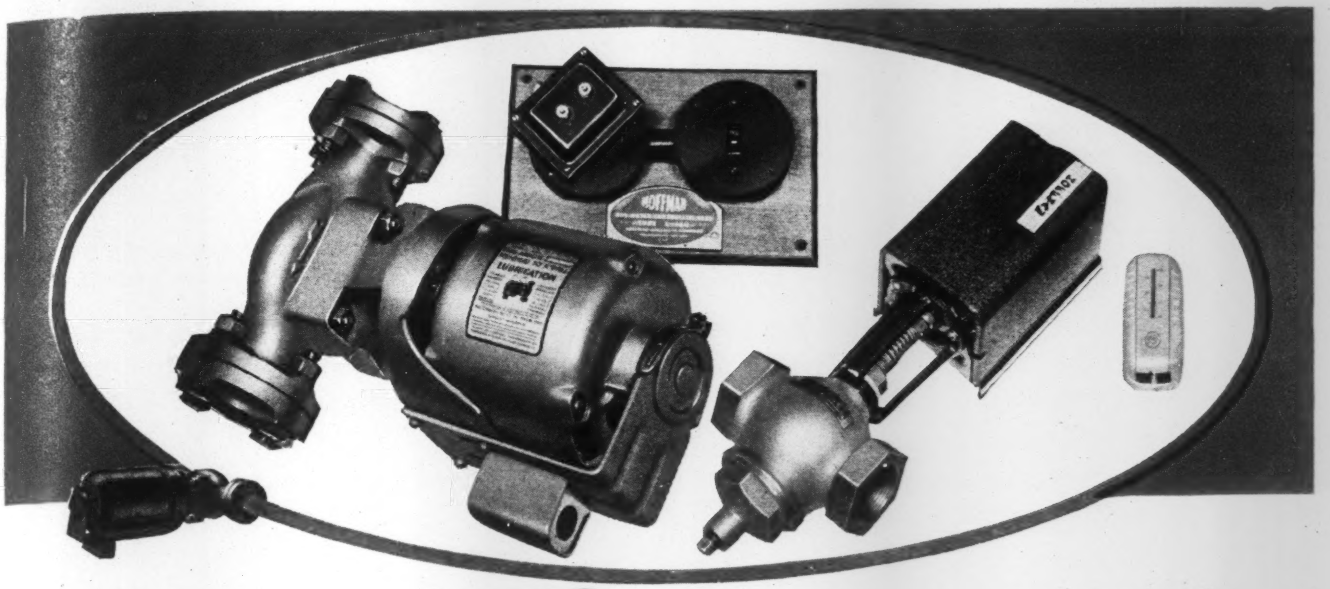
No. 2806—The Trane Co., La Crosse, Wis., has enlarged its line of propeller type fans to include new models and a greater variety of sizes. These fans may now be obtained with either two or four blade propellers with direct or belt drive. The two blade fans are available in sizes ranging from 15 to 48 in. in diameter. Four blade fans start with a 10 in. diameter and extend through 72 in. Both belt and direct drive fans may be obtained with the motor outside the air stream. A new cradle type of fan mounting in a wide range of sizes of either two or four blade propellers is also being built. All standard fan motors and bearings are available.

The scientifically designed fan blade, which has established its ability to handle large volumes of air at a minimum noise level, has not been changed, says the manufacturer.

Creates Air Conditioning Division

No. 2807—Ellis L. Spray, vice president and general manager of the Westinghouse Electric Elevator Co., announced recently the creation of two separate divisions, the air conditioning and elevator divisions.

Ross Rathbun, formerly manager of air conditioning, has been appointed manager of the expanded air conditioning division, which now includes the "Precipitron;" and Walker G. White, formerly sales manager, has been named manager of the elevator division. George F. Begoon, has been named manager of the "Presipitron" department of the air conditioning division.

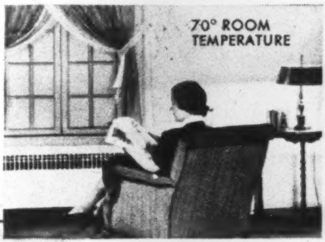


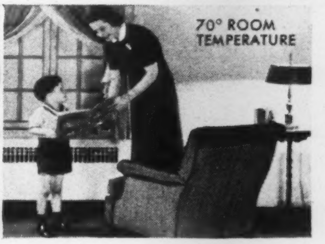
HOFFMAN *Comfort Package*

Thermostatically Controlled CONTINUOUS CIRCULATION hot water heat...
for COMFORT-HUNGRY PEOPLE

WHEN IT'S JUST RAW AND WINDY

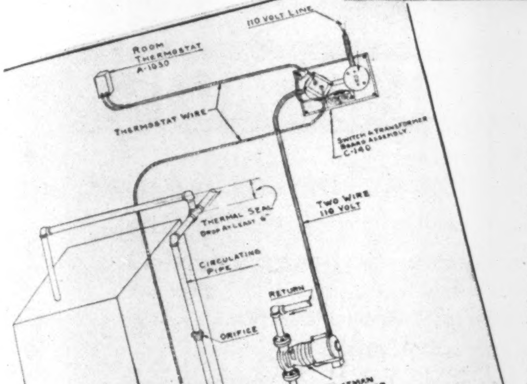
On comparatively mild days, as in the Spring or Fall, the Hoffman *Comfort Package* eliminates the wasteful overheating which usually occurs in less sensitively controlled heating systems. Hence, much more comfort on much less fuel.


70° ROOM TEMPERATURE


70° ROOM TEMPERATURE

.. OR WHEN IT'S BITTER COLD

When the thermometer starts for the bottom, the Hoffman *Comfort Package* automatically increases the heat supply. All so smoothly and gradually that room temperature remains constant throughout all changes in the weather.


110 VOLT LINE
ROOM THERMOSTAT A-1030
THERMOSTAT WIRE
SWITCH & TRANSFORMER PANEL ASSEMBLY C-140
THERMAL SEAL DROP AT LEAST 6"
TWO WIRE 110 VOLT
CIRCULATING PIPE
RETURN
ORIFICE
HOFFMAN CIRCULATOR C-162 (SIZE AS SPECIFIED)
BOILER
CONTROL VALVE D-2 (SIZE AS SPECIFIED)

Offered at a popular price . . . adaptable to new or old hot water heating systems

Anybody can now afford the luxurious, controlled warmth of *continuously circulated* forced hot water heat. The new, simplified and inexpensive Hoffman Comfort Package ends uneven, spotty heating—saves fuel because it prevents the generation of unnecessary heat. Here's heating comfort at its best, yet the cost comes within the budget limit of low-cost homes.

The Hoffman Comfort Package can be applied to any kind of automatically-fired hot water heating system. Its equipment consists of Circulating Pump, Control Valve, Thermostat and Control Panel. In operation these units effect a *constant balance between heat loss and heat supply,* so that home temperature is kept uniform, regardless of weather variations.

Note in the diagram that the boiler is by-passed from the rest of the circulating system. Hot water from the boiler is admitted only when the temperature of the circulating water drops below the temperature required by weather conditions. Hence the system keeps pace with the actual need for heat and never delivers a fuel-wasting excess.

For more complete information, send the coupon.

Guardian of Your Fuel and Comfort

HOFFMAN SPECIALTY COMPANY

1001 York St., Indianapolis 7, Indiana

Makers of Valves, Traps, Vacuum and Condensation Pumps, Forced Hot Water Heating Systems . . . sold everywhere by wholesalers of Heating and Plumbing equipment.

Hoffman Comfort Package

HOFFMAN SPECIALTY CO.
1001 York St., Dept. FG-5, Indianapolis 7, Ind.
Send at once your booklet on the new Hoffman Comfort Package.

Name..........................*Title*..........

Firm Name......................................

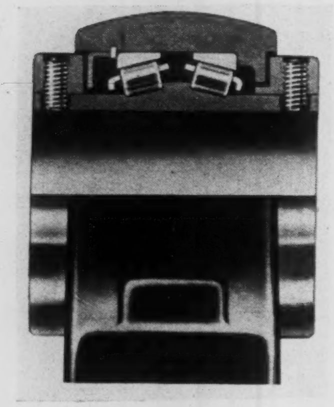
Address..

City..............................*State*.........

Stockholders of the Westinghouse Electric and Mfg. Co. at a recent annual meeting voted to change the company's name to Westinghouse Electric Corp., for simplicity and brevity. They also voted to split the company's stock on a basis of four shares for one.

Pillow Block and Flanged Bearing Units

No. 2808—The Dodge Mfg. Corp., 500 S. Union St., Mishawaka, Ind., announces a new bearing known as "Type E" which is now available in both pillow blocks and flanged units. It is designed to give 30,000 hr or more of service under conditions for which it is adapted.



The method of fastening to the shaft is said to be simple and effective. On each end of the extended inner race is a steel collar having two headless set screws spaced 120 deg apart and extending through clearance holes in the inner race to the shaft. These four set screws provide a positive lock to prevent rotation of the inner race on the shaft. The housings are compact and are precision machined to close tolerances on automatic machines.

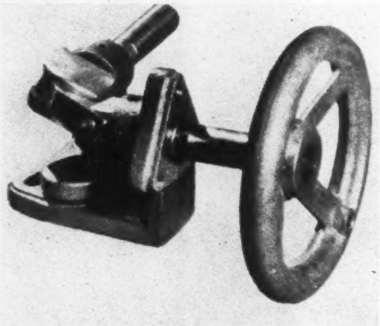
Labyrinth seals prevent loss of lubricant and protect the bearings against damage from dust, dirt, or moisture. These seals are equally effective whether the bearing is on or off the shaft, the manufacturer says. The bearings are completely assembled, lubricated, and adjusted at the factory.

Moves Offices and Factory

No. 2809—Maid-O'-Mist, Inc., Chicago, manufacturers of automatic humidifiers and heating specialties, recently have moved their offices and factory to their own building at 3217-19 N. Pulaski Rd., Chicago 41, Ill. According to company officials, the move to the new and larger three-story structure has been necessitated by current war contracts and plans for postwar expansion.

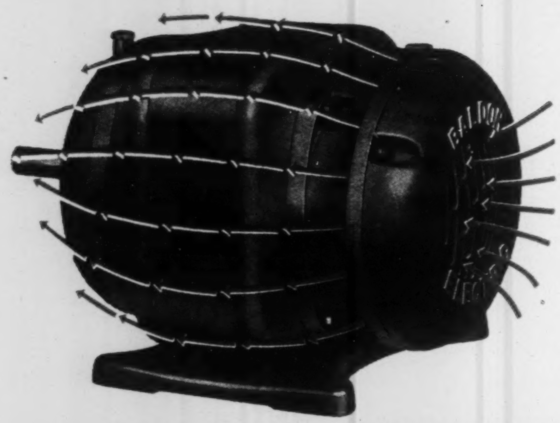
Universal Link Joint

No. 2810—The "Piezo" universal link joint is a remote control introduced by Piezoelectric Corp., 110 E. 42nd St., New York 18, N. Y. It features an adjustable link mechanism to transmit rotary motion around corners, permitting the operation of shafts at angles adjustable from a straight line, 0 deg to a right angle, 90 deg. With the use of solid shafting and the absence of flexing or backlash this



THE MOTOR for MANY APPLICATIONS

It's the BALDOR STREAMCOOLED MOTOR



Arrows indicate air travel over ENTIRE EXTERIOR of Baldor Streamcooled motor.

This ALL-PURPOSE MOTOR will simplify your Designing, Purchasing, Production and Inventory. Check these features with your motor specifications:

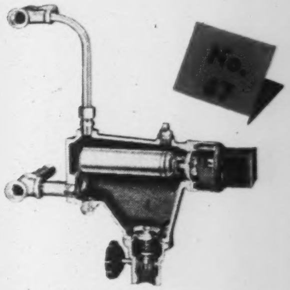
1. Totally enclosed — ball bearing.
2. Drip-proof; splash-proof; grit-proof; lint-proof.
3. Horizontal, vertical and side wall mounting.
4. Removable base.
5. End plates interchangeable for face mounting.
6. Standard NEMA dimensions.
7. Standard or glass insulation.

BALDOR ELECTRIC COMPANY, St. Louis 10, Mo.
District Offices in Principal Cities

PLAN YOUR POST-WAR MOTOR REQUIREMENTS *Now.* Get the Latest BALDOR Bulletins

McDONNELL
No 154
"Silence is golden"

The cut-off used in the Maxim unit is a variant of our standard No. 150 Low Water Cut-off and Pump Control for automatically fired boilers with steam pressures up to 150 lbs. Here is a device for those vital high pressure boilers, built from float to switch to meet the challenge of high pressure and temperature. It can be used as a low water cut-off, as a low water alarm, as a control for condensation pump, or for any combination of these functions.



The world's most widely used low water cut-off for the big group of automatically fired boilers with steam pressure up to 25 lbs. It has the McDonnell Quick-Hook-Up, packless construction, deep sediment chamber, large blow-off valve and many other advanced features.

. . . and so is steam from waste heat

This combined silencer and waste heat boiler was installed by Maxim Silencer for the Maritime Commission. It silences the exhaust of internal combustion engines, totalling about 1200 hp., and utilizes the heat of the exhaust to generate 1000 pounds of steam per hour at 60 lbs. pressure—a real heat recovery just as "golden" as the silence.

Vital to the operation and safety of the boiler is the McDonnell No. 154 Low Water Cut-off and Pump Control for high pressure boilers. Its use here is one more example of countless demands made upon us during the war for water level controls applied to equipment ranging from big boilers down to steam jacketed kettles. Applications like this won't wait, and that's why some of your orders—even those carrying high ratings—have been delayed.

Somehow it always rubs us the wrong way when suppliers tell us they are "sorry about the delay"—partly because it's so easy to say; mostly because we want to know the facts. So we simply cite the facts here—give you one of the many examples of inescapable reasons for holding up orders. The only consolation is the broadened experience we are acquiring—"know-how" and facilities that will mean much to you and to us in days to come.

"DR SHUSH" KNOWS HIS STUFF—

The name, Maxim, is synonomous with highest engineering standards. Therefore it is significant that organizations like the Maxim Silencer Company choose McDonnell Boiler Water Level Controls for a function of their equipment on which its safety rests.

McDONNELL & MILLER, 1316 Wrigley Bldg., Chicago 11, Ill.

Doing One M&M SAFETY CONTROLS *Thing Well*
REG. U. S. PAT. OFF.

McDONNELL

Boiler Water Feeders • Low Water Cut-offs

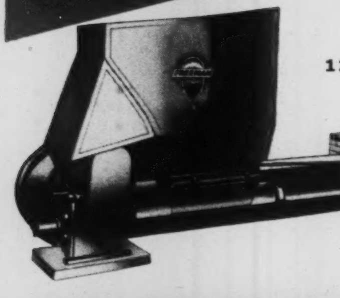
You CAN MAKE MONEY IN THE STOKER BUSINESS NOW AND POST-WAR with

FREEMAN
LONG-LIFE
STOKERS

FIRST CHOICE OF AMERICA'S
FOREMOST HEATING ENGINEERS

...A PIONEER OF THE STOKER INDUSTRY AND ONE OF THE LEADERS IN NATIONAL SALES VOLUME!

COMPLETE RANGE
OF SIZES UP TO
1200 POUNDS PER HOUR



FREEMAN STOKER DIVISION
ILLINOIS IRON & BOLT CO.
918 S. MICHIGAN AVE., CHICAGO 5, ILLINOIS

makes an ideal method for accurate remote controls, the manufacturer says.

An important feature of this joint is the fact that the output shaft turns in the exact angular rotation as the input shaft, giving an input turning angle equivalent to the output turning angle. This is of particular importance in dial settings and where uniform motion is desired.

The joint is mounted by means of three screws which hold it in position. The bearing arm which holds the adjustable shaft may be hinged to any desired position from 0 to 90 deg and when in its proper location, a locking screw permanently holds its position. These universal joints are recommended by the manufacturer for use in power houses and large heating installations where it is difficult to reach the valves.

Molding Powder

No. 2811—Molded synthetic rubber parts with excellent resistance to solvents, greases, oils, fuels, sunlight, ozone, and atmospheric oxidation are now possible, the manufacturer says, through the use of a new molding powder developed by the Thiokol Corp., Trenton, N. J. The powder, which becomes vulcanized at 300 to 360 F to form a tough resilient solid, has proved itself an excellent material for compounds which are required to remain flexible at temperatures below —50 F and remains serviceable to temperatures in excess of 220 F.

Technicolor Film on Arc Welding

No. 2812—The Lincoln Electric o., 12818 Coit Rd., Cleveland 1, Ohio, has released a Technicolor sound motion picture titled "Magic Wand of Industry—Arc Welding." This 25 min presentation, produced at government request, portrays the progress of arc welding from its beginnings to its present vital wartime role. Under the technical direction of welding engineers, this film was staged and photographed in practically every major industry. The film presents the fundamentals of arc welding, the electrical circuit, and the types of welded joints. The action inside the arc is also revealed trating "arc force." Sixteen mm and 35 mm prints of in actual photography and animation, showing the pene- the film are available at no charge except transportation.

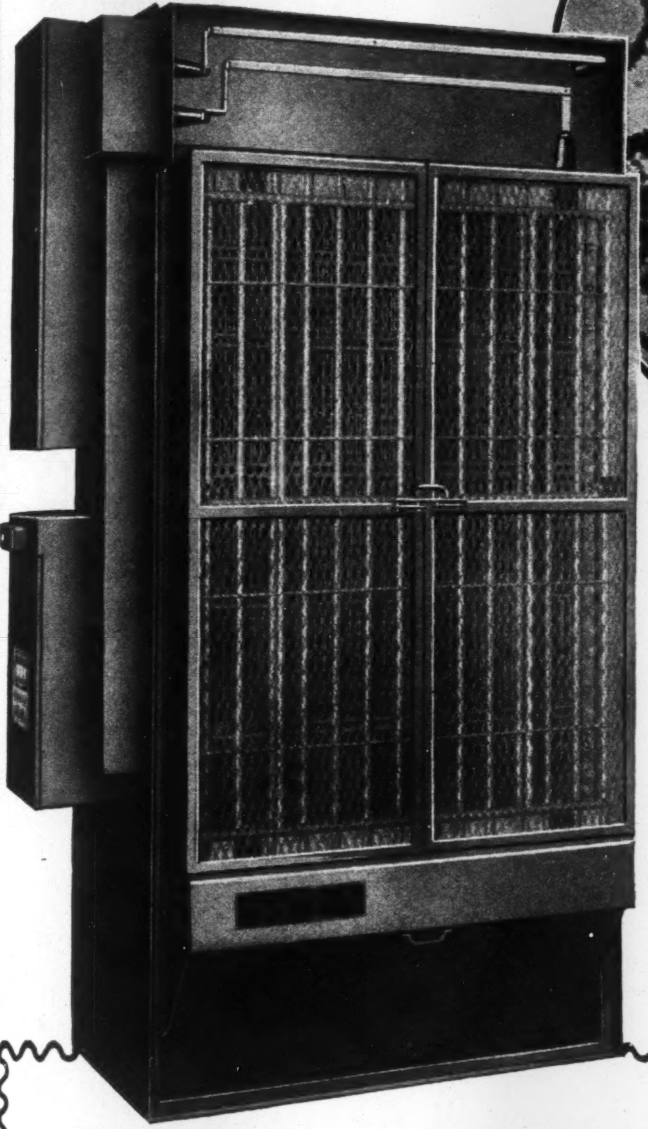
Radiation Pyrometer

No. 2813—Five improvements just introduced in "Radiamatics" will make this compensated radiation pyrometer secure against air and gases up to 1 psi gage pressure at temperatures up to 250 F, it is said by the manufacturer, the Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., 4534 Wayne Ave., Philadelphia 44, Pa.

The improvements comprise use of an adhesive sealing compound between the lens and mounting ring; use of brass for lens retaining and mounting rings; controlled torque applied when assembling the lens retaining and mounting rings; two spanner wrench holes in the lens mounting ring face replaced with a milled slot which avoids cutting through the ring face; and use of a more positive sealing, with an improved adhesive, of the sighting glass in the rear of the thermopile assembly. Other improvements include use of aluminum instead of cast iron for the housing.

Smoke

HAS TO BE MAGNIFIED 40,000 TIMES TO LOOK LIKE THIS:



. . . YET SMOKE AND OTHER FRACTIONAL MICRON-SIZE PARTICLES ARE REMOVED BY THE ELECTRO-MATIC WHICH PROVIDES SUPER-CLEAN AIR!

Only the new electronic microscopes, will show all the particles of dust that the Electro-Matic Air Filter will remove. By first giving dust particles an electrostatic charge, then attracting them electrically to viscous surfaces, the Electro-Matic makes possible a degree of cleanliness in plant atmospheres that is unapproachable by other means. In addition, this equipment is rugged, automatic and self-cleaning (an exclusive AAF development) assuring continuous operation at peak efficiency.

Super-clean air for commercial and industrial concerns is guaranteed by the Electro-Matic

The use of filtered air to protect the health and comfort of employees is not just altruistic but a sound business investment. A large industrial insurance company estimates the time lost by employees due to colds and other dust borne respiratory reasons is costing business millions of dollars each year. This does not take into consideration the indirect losses resulting from production slow down, costly mistakes and the unavoidable waste due to inexperienced operators replacing absent key workers. Nearly every type of industrial plant and commercial concern is represented among the users of AAF equipment. For complete information on the Electro-Matic Air Filter send for Bulletin 250-D.

AMERICAN AIR FILTER COMPANY, INC.
Incorporated
373 Central Avenue LOUISVILLE 8, KY.
In Canada: Darling Brothers, Ltd., Montreal, P. Q.

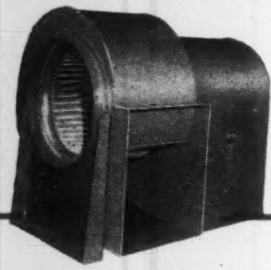
AAF

ELECTRO-MATIC THE SELF CLEANING ELECTRONIC AIR FILTER

MAKE YOUR VENTILATING JOBS *Peerless Electric*

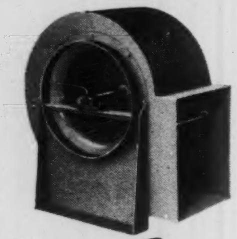
and get the benefits of 50 years' experience in building quality motors and electrical apparatus

- 26 BELT DRIVE SIZES
- 12 DIRECT DRIVE SIZES

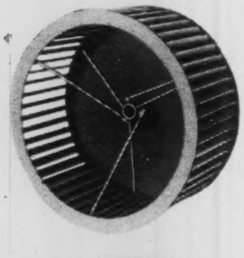


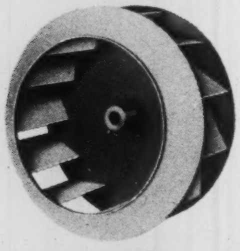
Peerless Electric
VENTILATING SETS

Belt drive units are powered with ½ to 7½ h.p. motors; direct drive units ½ to 2 h.p. motors. All units supplied with or without weatherproof hood covers for drive mechanism.



Peerless Electric
VENTILATING BLOWERS
SIZES 12" to 48"
Shown here in Arrangement 3





Peerless Electric
BLOWER WHEELS

Forward curve and backward curve blower wheels full welded construction carefully balanced for smooth, quiet rotation.

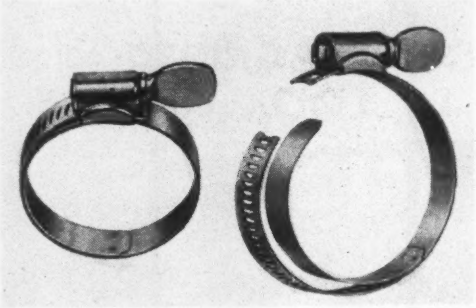
No matter what your needs—for small jobs or large jobs—it will pay you to make Peerless your headquarters for ventilating equipment. More than 50 years of experience have given Peerless Electric the "know-how" that enters into the design and manufacture of Peerless Electric fans, blowers and ventilating equipment, entirely in our own modern plant. Peerless Electric is small enough to study your needs and special applications intimately—large enough to supply your complete requirements.

Write us for details on any standard Peerless Electric ventilating equipment, or tell us your special problems.

THE *Peerless* ELECTRIC COMPANY
WARREN, OHIO
Established 1893

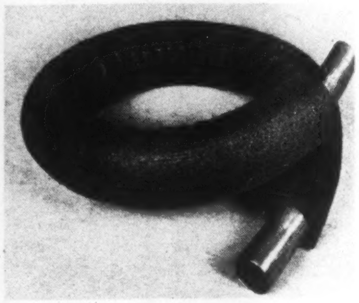
Worm Drive Hose Clamp

No. 2814**—A new worm drive hose clamp incorporates an inner band of stainless steel which protects the hose from the serrations in the outer band and distributes the load uniformly to provide greater strength and superior sealing characteristics, the manufacturer says. The hose clamp has a compact streamlined housing and a one piece thumbscrew. The clamp is available in eight adjustable sizes to cover the entire range of applications. It is made by Wittek Mfg. Co., Chicago 23, Ill.



Wool Felt Helps Armed Forces

No. 2815—The Felt Association, Inc., 480 Lexington Ave., New York 17, N. Y., reports that felt tubing, laminated and coated with plastic, is being slipped over flexible metal tubing on ice making units used by the armed forces. This is said to prevent metal from stiffening and breaking from cold, and also to provide insulation an check freezing.



Electrode Holder

No. 2816—A new screw type electrode holder—lighter to decrease fatigue—has been announced by the Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.

Exposed metal surfaces of the new electrode holder are constructed of spatter-resistant Mallory metal. Simplified design facilitates replacement of parts, and heavy insulation and adequate handle ventilation provide cool operation.

It is available in light and heavy duty sizes to accommodate electrodes up to ⅜ in. diameter.

Flush Door Latch

No. 2817**—A flush door latch, just introduced by the Hartwell Engineering Co., 3417 Crenshaw Blvd., Los Angeles 16, Calif., speeds the opening and closing of inspection and access doors. The latch was designed originally for combat planes and completely eliminates projecting knobs.

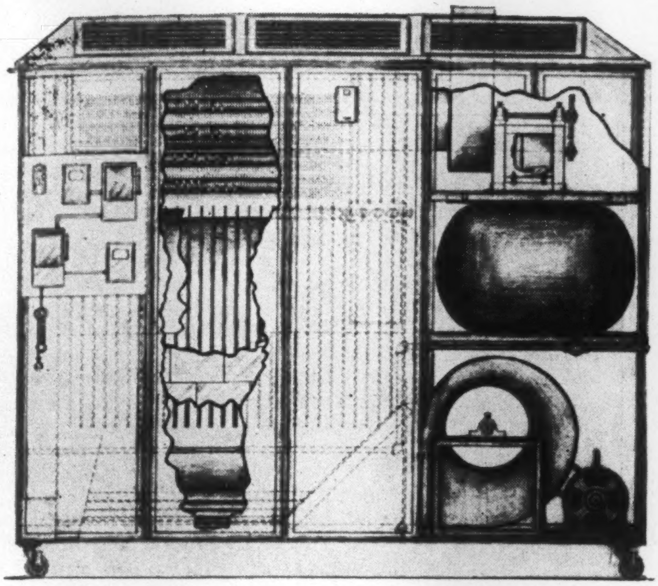
Pressure on the trigger of the latch releases the bolt and the door pops open. To lock the door shut, pressure is applied to the bolt.

The latch is made of stainless steel and twin springs control the bolt and trigger action. It can be supplied unmounted or spot welded to an installation plate. The latch may be used on metal, plastic, or wood, and can be adapted to doors of various sizes and thicknesses, says the manufacturer.

READY FOR

Immediate Action

ANY TIME
ANY PLACE



NATIONAL CHAMPION

"MOBILE HEATER"

DIMENSION AND PERFORMANCE DATA										
HEATER MODEL NUMBER	OVERALL DIMENSIONS APPROXIMATE			B.T.U. OUTPUT PER HOUR	C.F.M. MIN.	APPROXIMATE WEIGHT	BLOWER	MOTOR	TUBES	
	WIDTH	LENGTH	HEIGHT						NO.	DIA.
P-100	54	88	84	300,000	4,900	1400	12" TWIN	1 H.P.	12	2"
P-150	54	94	87	500,000	7,500	1700	14" TWIN	1.5 H.P.	16	2"
P-200	59	100	92	750,000	8,800	2000	18" TWIN	2 H.P.	22	2"
P-250	58	108	95	1,000,000	10,000	2300	18" TWIN	3 H.P.	30	2"

★ UP TO 1,000,000 BTU's BY JUST PLUGGING IT IN! This revolutionary new heater is built in 300,000 — 500,000 — 750,000 — 1,000,000 BTU capacities. Operation is started, *any place,* by simply plugging in to an electrical circuit. It is factory tested and ready for immediate use for all heating, drying and dehydrating purposes.

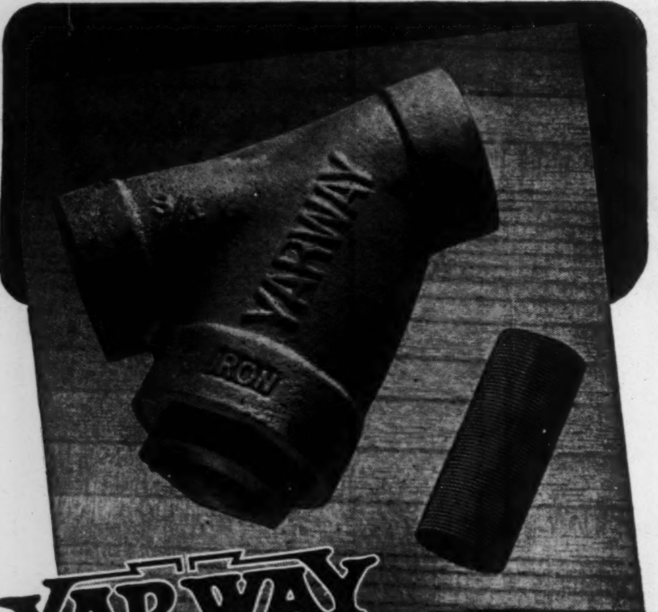
★ PORTABLE, MOVABLE, NO ASSEMBLY All units are enclosed in a rigidly constructed iron panel casing which permits easy moving. It's ready-to-go, when delivered, and completely assembled.

★ A HUNDRED-AND-ONE USES This heater gives *quick* heat whenever or wherever it is needed . . . and also is recommended for garages, storage spaces, industrial shops, drying refrigerating equipment, airplane hangars, etc.

WRITE FOR FULL INFORMATION

NATIONAL HEATER COMPANY

MINNEAPOLIS 2 • 400 ESSEX BLDG. • MINNESOTA



YARWAY

STRAINERS

"*Police the Pipelines*"

YARWAY STRAINERS are *selling by the thousands* because they are better engineered for the service.

"*The Screen is the Thing*"—a high-grade, woven Monel wire screen that stops the dirt, lets fluids flow freely.

Then, too, purchasers like the *body finish—Cadmium plating inside and out* for protection against corrosion.

And last but not least, it is "*Easy to Clean*" having a steel blow-off bushing, precision machined with straight thread. Screen and bushing come out together—go back together, automatically aligning.

Six sizes, ½" to 2" for pressures up to 600 lb serve practically all strainer needs.

Sold by over 100 Mill Supply Houses. See your Supply House or write for Bulletin S-200.

YARNALL-WARING COMPANY
107 Mermaid Ave. PHILADELPHIA 18, PA.

YARWAY STRAINERS

Manufacture of Heavy Wall Pipe

Condensation of a paper by E. C. Wright, assistant to president, National Tube Co., presented in the Bulletin of the American Society for Testing Materials.

Most heavy wall, large diameter, seamless pipe has been used for steam mains connecting high pressure boilers with turbines. Occasional uses are also found in chemical plant and oil refinery equipment, and for special hydraulic piping used at room temperature. Pipe for high temperature use has been purchased to ASTM specification A-206-447.

Few steel mills can roll rounds over 7 in. in diameter, such as are required by seamless tube mills. As a result, the purchase of rounds in small quantities for small orders of pipe becomes troublesome. Unless a whole heat of steel is purchased, large rounds can usually be obtained only in forged sizes. Since these are quite rough and inaccurate in diameter, the tube manufacturer must turn or peel such rounds to remove surface defects and get accurate dimensions for piercing.

The steel melter is also troubled with the problem of selecting the proper ingot size and weight to cut billets. Often the available ingot mold size and weight of ingot is such that only 50 to 60 per cent of the ingot can be cut to the proper weight billet. This is particularly true in the case of alloy steel melting shops with electric furnaces where ingot weights rarely exceed 15,000 lb and where 8000 to 10,000 lb ingots are usually standard equipment. Thus, it is possible to cut only one round billet weighing between 4000 and 6000 lb from an ingot weighing 10,000 lb, since the normal crop loss from hot topping and bottom cropping frequently exceeds 25 per cent.

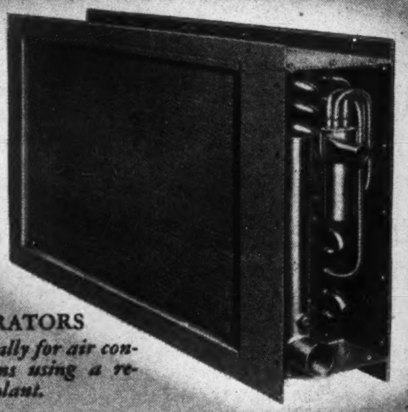
With an order for very large sizes, such as 16 in. OD x 1 9/16 in. wall, the ordinary mill setup used for rolling 16 in. OD pipe of nominal wall thickness is not satisfactory and it is necessary to adjust the first and second piercers, use a different Hi-mill bar and plug, change the reeling machine, and sometimes change the sizing rolls. In addition, the billet weight for such a pipe size is so heavy, often being over 6000 lb, that the heating furnace will not accommodate the desired round because of excessive length. This requires the use of a billet of greater diameter than normally required to keep the length within the heating furnace limit. Therefore, the piercing mill passes used for ordinary 16 in. OD pipe cannot be employed.

As a result of these conditions, extensive changes and rearrangement of equipment always becomes necessary when special heavy wall pipe is to be made, either when the pipe mill has previously been rolling a similar diameter with a light wall, or a smaller diameter. It takes from three to five hours to change the mill setup, and the cost of this nonproductive delay is high.

Orders for large diameter and heavy wall pipe rarely exceed 1000 ft. and this represents only forty pieces 25 ft long. Such a quantity can ordinarily be rolled in 1 to 2 hr. The total mill time employed in producing 1000 ft. of a special size would approximate 10 hr, so the operating cost and overhead charges per ton for producing such quantities in these sizes are often from five to 10 times those for producing a given quantity of ordinary pipe and tubing sizes. Further, the rolling of special sizes on the mills is extremely difficult and frequently a number of pieces are cobbled or lost due to difficulties in handling the heavy billets and to the lack of experience of the crews in setting the mills and operating them. As a result, large rollings of special analysis and special large diameter heavy wall pipe are never made, since they are not standard purchases and overages of these odd pipe sizes cannot be sold within a reasonable time and frequently must be scrapped.

Due to the fact that special heavy wall alloy steel tubes are used for very high pressures and severe temperature conditions, the inspection of the finished material is most severe. It is necessary to pickle or descale the surface of the metal to develop the defects, and then a considerable amount of grinding is required for the removal of pits, scratches, and light seams. Frequently a long length must be cut in the center to remove a defect. It is mainly because of the severe inspection that the mills insist upon shipping short lengths down to 6 ft.

Coils ONE AT A TIME OR BY THE CARLOAD



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igned especially for air con-
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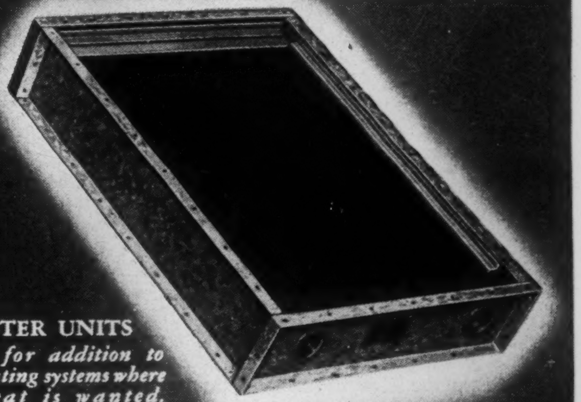

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Designed for addition to central heating systems where extra heat is wanted.

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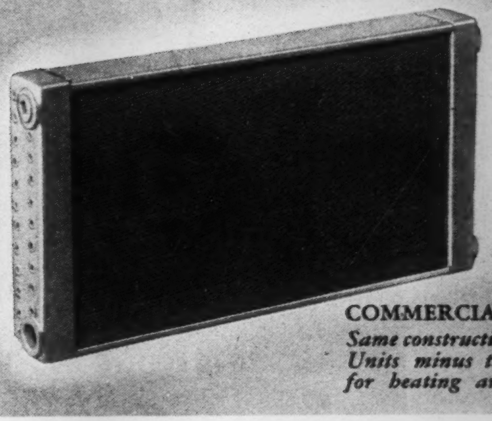
steam heating systems.



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Same construction as B
Units minus the casi
for heating and cool

● No coil job in the heating, cooling and air conditioning field is too large or too small for Young. There are versatile Young Units for every need. From architects, engineers . . . men responsible for results . . . comes testimony of the dependable performance of Young Heat Transfer Surfaces in office buildings, auditoriums, schools, theaters, stores, restaurants and other places where people gather . . . in drying rooms, paint spray booths, malt houses, dry kilns and dozens of types of commercial installations. Write for Young Coil and Evaporator catalog . . . there is no obligation.

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HEAT TRANSFER PRODUCTS
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OIL COOLERS • GAS, GASOLINE, DIESEL ENGINE COOLING RADIATORS • HEAT EXCHANGERS • ENGINE JACKET WATER COOLERS • UNIT HEATERS • CONVECTORS • CONDENSERS • EVAPORATORS • AIR CONDITIONING UNITS • HEATING COILS • COOLING COILS • AND A COMPLETE LINE OF AIRCRAFT HEAT TRANSFER EQUIPMENT

YOUNG RADIATOR CO., Dept. 115-E, RACINE, WISCONSIN, U.S.A

ASTM specification A-206 has been changed every year since it was originally written. This has made it impossible for manufacturers to stock special, heavy wall, large diameter pipe sizes, and the changes in chemical analysis and steel melting practice which are being considered for this specification make it utterly impossible to consider any stock for at least the next two years.

As a result of these complexities, it has become evident to the author's company that the only way in which such special pipe can be manufactured on any basis approaching a commercial production operation is to standardize on the following features:

1) Roll only certain wall thicknesses, such as schedule 120 and schedule 160, for any given diameter.
2) Roll only one length in any given diameter and wall thickness.
3) Purchase billets of only one diameter and weight for rolling each size of pipe. This will enable the mill to produce one standard length of pipe in each size.

It is suggested that a table be incorporated in ASTM specifications instead of the present American Standard B36.10-1939. Under the proposed suggestion it will be possible for mills gradually to accumulate a stock of round billets suitable for rolling a given pipe size, the length varying according to the mill's facilities. Rollings of the pipe must be limited to minimum quantities of 1500 ft, which will make it necessary for consumers to purchase such a quantity or have their orders for lesser amounts accumulate at the producer's plant. Any excess from these rollings can then be placed in stock in the standard lengths, much like ordinary pipe is stocked. When such stocks are accumulated in the standard diameters and wall thicknesses, orders for small quantities may be entertained by cutting small amounts from such stocks. This situation, however, cannot be attained until a definite and standard specification is written and adhered to without annual changes.

Estimates Housing Needs

Maximum housing needs of the United States from 1946 through 1960 will call for the average annual construction of about 1,500,000 family dwelling units to house our farm and town families, J. Frederic Dewhurst, economist for the Twentieth Century Fund, testified before the Senate small business committee May 9.

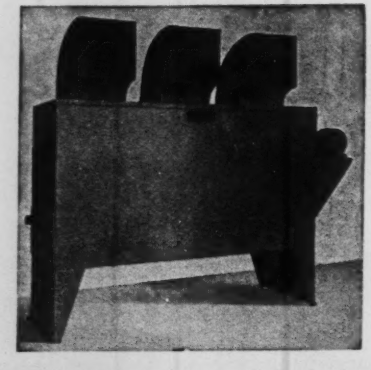
The total city dwelling needs during the 15 yr period are estimated at about 19.5 million new units, calling for the expenditure of $76,000,000,000, Mr. Dewhurst testified. Speaking of farm dwellings, he indicated that during the 15 yr period maximum needs will be about 2,900,000 dwelling units, calling for the expenditure of approximately $5,800,000,000. These figures are based on 1940 price levels and average expenditures for dwelling units prior to the war.

Beardsley Ruml, chairman of the business committee of the National Planning Association, testified that past experience has shown that public works cannot be used successfully as the only or principal means of combating unemployment, because of the high level of expenditures required for this purpose. He informed the small business committee, however, that public works can be used to help stabilize the construction industry—adding that this, in itself, is no small contribution to the solution of unemployment.

He pointed out that the construction industry is characteristically unsettled, fluctuations in the volume of construction resulting from many factors peculiar to its nature as well as to general business conditions. Consequently, he said, it has been necessary for the industry to maintain a high level of prices, "so that the days and hours of activity would pay for the time when there was little or nothing to do." When construction activity is slow, he said, returns to persons engaged in the industry are low and they must spread their returns from levels of high activity to cover the valleys of depression.

BUY AN EXTRA WAR BOND

Plan Now FOR NEXT SEASON'S HEATING REQUIREMENTS



Now is the time to be planning your heating needs for next season. There is an Airtherm Unit Heater to properly, efficiently heat any plant with a saving in fuel.

AIRTHERM PROPELLER TYPE STEAM UNIT HEATERS

Airtherm Steam Unit Heaters are individually controlled. They provide heat only where you want it, and when you want it. They are available in both vertical delivery and horizontal delivery types for ceiling or wall mount.

AIRTHERM BLOWER TYPE STEAM UNIT HEATERS

A high velocity unit which assures uniform temperature distribution and maximum heat flow effecting savings in both fuel and maintenance cost. This Airtherm Unit is suited to duct installation. Capacities range from 216,000 to 825,000 b.t.u.

Send us your specifications now. Our engineering department is at your service.

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MANUFACTURING COMPANY
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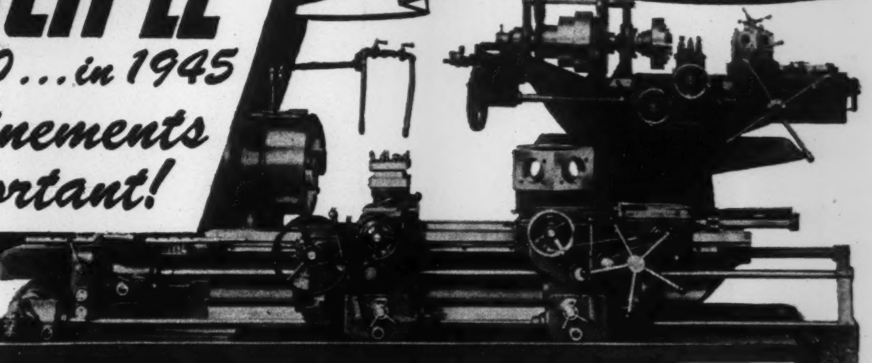
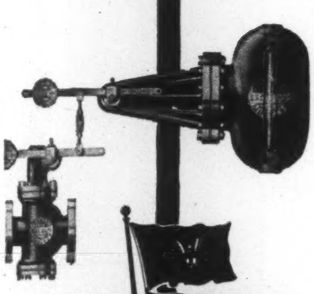
THE PRINCIPLE

is the same . . . in 1890 . . . in 1945
BUT . . . *the refinements are mighty important!*

Years of experience . . . dramatized by a Gisholt high production turret lathe shown in contrast to a Gisholt machine of 1890.

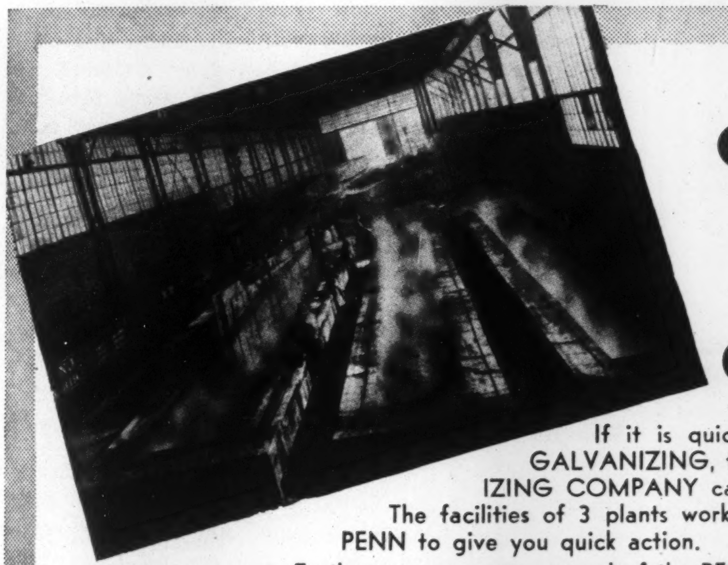




There's little difference in principle between the "belt driven screw machine" of 55 years ago and the ultra-modern Gisholt turret lathe of today. *But in practice* . . . ah! . . . 7 to 10 times the production per man-hour . . . heavier feeds . . . smoother cuts . . . more accurate work! Better machining with such greatly improved machines is partly the answer to the dependable efficiency of Kieley & Mueller Controls . . . but *experience* must get most of the credit. For Kieley & Mueller experience, like Gisholt's, inspires steady progress in design, production and performance. Type 250 Liquid Level Control is a typical example. For maintaining constant levels in open or closed vessels, there is no device more sensitive. The "pack-ezy" ball bearing stuffing box minimizes friction, is tight under pressure or vacuum, and may be repacked in the field with ordinary tools. Value bodies have large open port areas, and removable and renewable seat rings. Sizes 1/2" to 6" with self-contained float cage. Yes, the principle of today's Kieley & Mueller Liquid Level Control is unchanged . . . *but the refinements are mighty important!* Write for Catalog No. 66.

KIELEY & MUELLER, INC.
MANUFACTURERS OF
PRESSURE AND LEVEL CONTROLS SINCE 1879
2015 43RD ST., NORTH BERGEN, N. J.

66 YEARS OF CONTROL PROGRESS



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If it is quick action you need on QUALITY HOT DIP GALVANIZING, then look no further . . . the PENN GALVANIZING COMPANY can take care of your iron and steel products. The facilities of 3 plants working 24 hours a day, 7 days a week, enables PENN to give you quick action.

Furthermore, you are assured of the PENNizing process of Hot Dip Galvanizing when PENN does it . . . a perfected rustproof coating that gives your iron and steel products long lasting protection at the most economical cost.

Let the Nation's largest do it to get the best results

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Safely Uniform
Warmth and Comfort

THIS Ap CONSTANT LEVEL OIL CONTROL

is standard equipment on most good oil-burning heaters now . . .

Just add the A-P ELECTRIC AUTO HEAT CONVERSION TOP to the A-P Control now on your heater.

Then install this A-P Thermostat on the wall, and you will have COMPLETLY AUTOMATIC HEAT CONTROL—always uniform and dependable.

● **For Homes where the Space Heater is Equipped with Ap Thermostatic Temperature Control . . .**

WIN the gratitude of your oil-burning Space Heater customers by helping them to stretch their fuel allotment—prevent fuel waste—and still enjoy uniformly warm homes in early spring. The A-P Thermostatic Temperature Control for Oil-Burning Space Heaters using A-P Model 240 DR or UR Manual Controls is the equipment that will insure this comfort and fuel-saving economy.

TEMPERATURE CONTROL like this soon returns much more than its original cost—in fuel savings and uniform heating comfort. Feature it NOW for sales and profit!

AUTOMATIC PRODUCTS COMPANY
2460 North 32nd Street Milwaukee 10, Wisconsin

Ap DEPENDABLE
Oil Controls

RECENT TRADE LITERATURE

For your convenience in obtaining copies of these bulletins, see coupon on page 187. If you write direct to the manufacturer, describe carefully what literature you want, as the number given first in each item is for use only when sending in your request to Heating, Piping & Air Conditioning.

Blast Freezing of Foods

No. 4946—A 16 page brochure covering the subject of blast freezing of foods has been issued by Carrier Corp., 302 S. Geddes St., Syracuse, N. Y. Detailed descriptions are given of standard units, suspended blast freezers, floor mounted freezers, freezing systems for special needs, refrigeration machines, and evaporative condensers.

Cast Iron Fin Type Radiation

No. 4947—D. J. Murray Mfg. Co., 1002-24 Third St., Wausau, Wis., has recently issued a six page folder desribing its cast iron fin type radiation, with details of design and construction. The folder contains installation views of cast iron "Grid" unit heaters, dimensional drawings, capacity tables, and supply and return connection drawings. Also included is an explanation of "carry-over" of heat due to the construction material.

Centrifugal Refrigeration

No. 4948—A 24 page brochure of the York Corp., Roosevelt Ave., York, Pa., traces the development of centrifugal refrigeration from the invention of the turbo-compressor for compressing gases, in 1906, to the present day. Many photographs, sketches, and diagrams illustrate the text, which gives details of present applications and future potentialities of turbo-compressors, as well as the history of their development.

Community Refrigeration

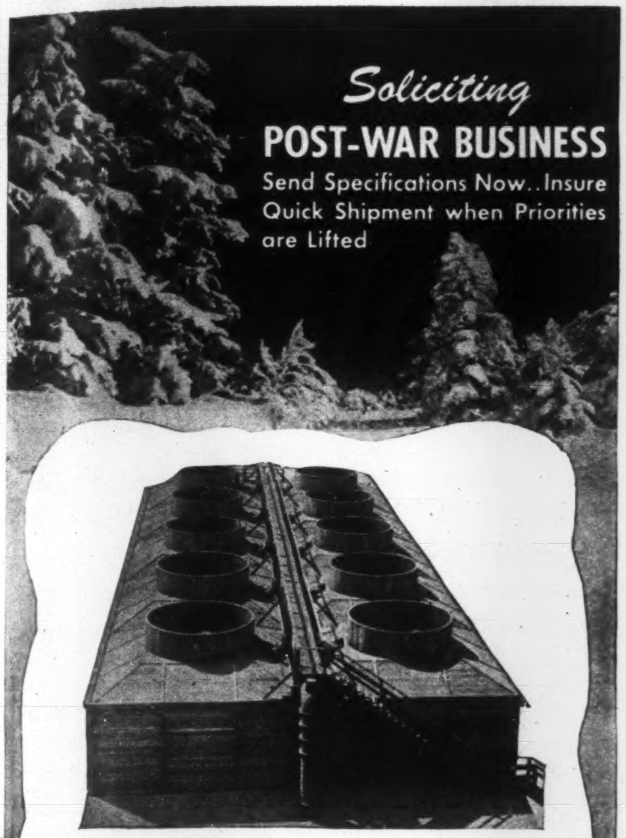
No. 4949—Varied services of a community refrigeration center serving a town of 2500 people are described in a four page bulletin of the Frick Co., Waynesboro, Pa. The center offers refrigeration for dozens of purposes, from quick freezing to fur storage.

Damper Regulators

No. 4950—A four page catalog (3) describes the damper line of the Young Regulator Co., 4500 Euclid Ave., Cleveland, Ohio. Included are data on surface mounted, concealed, and remote control types, relief and fresh air dampers, air-split damper regulators, etc.

Electric Contact Heaters

No. 4951—The H. & A. Co., 86-100 Leroy Ave., Buffalo 14, N. Y., has published a 16 page booklet telling the story of the company's development of small, lightweight, low wattage heaters for combat aircraft. These contact heaters have proved effective in preventing freezing of gun mechanisms and hydraulic equipment at high altitudes where temperatures range lower than 65 deg below zero, says the manufacturer.



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POST-WAR BUSINESS

Send Specifications Now..Insure Quick Shipment when Priorities are Lifted

FACTS OF L-H INDUCED DRAFT COOLING TOWERS

Air is drawn through louvred openings at base; passes upward through eliminators; then out fan throat at top.

As air flows upward, it mixes with descending drops of water; reaches the top in a saturated condition; then is discharged into the atmosphere.

A high wood stack above fan eliminates recirculation of air.

REASONS FOR TREND TO THIS TYPE

(1) Less ground space. (2) Less affected by freezing weather conditions. (3) Less fan noise. (4) Greater adaptability to modern design.

GENERAL DATA

New type removable filling gives uniform distribution of water and air over entire effective area of tower. Built in either single or multiple cells; can be arranged with all cells-in-line, or back-to-back construction.

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COOLING TOWERS, INC.

Manufacturers of All Types of Water Cooling Towers

GENERAL OFFICE: 4239 DUNCAN AVE., ST. LOUIS 10, MO.
PLANTS AT ST. LOUIS, MO., AND PLAINVIEW, TEXAS

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OIL BURNING SYSTEMS

Petro Class A (Industrial) Equipment is currently available under W.P.B. regulations and ratings.

Petro equipment includes:

DOMESTIC "CONVERSION" BURNERS
1 to 6 gal. per hour

LARGER "LIGHT (No. 3) OIL" BURNERS
general application type
6 to 18 gal. oil per hour

COMBINATION BURNER-GENERATOR UNITS
both steel and C. I. sectional boilers; forced warm air units; and instantaneous water heaters.

INDUSTRIAL OIL BURNERS
Manual - Semi Auto - and Automatic* for either un-heated or pre-heated industrial oils, up to 145 g.p.h. Built-in motor or belt drive.

****When pre-heated oils are burned the Petro Thermal Viscosity system insures consistent maximum combustion efficiency at all firing stages, automatically and reliably.***

Petro Engineering co-operation is still available. Research-development is active. When your post-war activities start, Petro will be ready for you.

OIL IS AMMUNITION
USE IT WISELY

Full data on Petro Industrial Burners are in our Catalog—see Sweet's or Domestic Engineering Catalog Files — or we will gladly send copies on request.

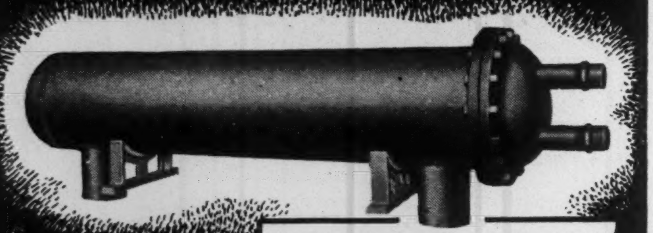
PETROLEUM HEAT AND POWER COMPANY

Makers of Good Oil Burning Equipment Since 1903

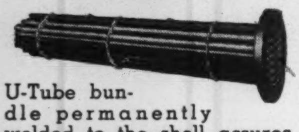
STAMFORD CONNECTICUT

Heat Exchangers

FOR EXCHANGE OF HEAT
BETWEEN GASEOUS AND LIQUID REFRIGERANT



FOR ALL
INSTALLATIONS
UP TO 180 TONS



U-Tube bundle permanently welded to the shell assures efficient heat transfer. Baffled tubes and multipass heads assure correct velocity of gas and liquid.

When compressor capacity is on the border line for load requirements . . . use a heat exhanger to assure satisfactory performance. It increases refrigeration effect and prevents liquid slugging and sweating suction lines. For all kinds of heavy-duty jobs Acme's Shell and U-Tube models have been delivering efficient service for many years. Their record of actual performance out in the field is creating a constantly increasing demand for Acme Heat Exchangers. Write for complete information—Catalog No. 12.

SHELL AND COIL
MODELS FOR SMALLER CAPACITIES

Acme Shell and Coil Heat Exchangers, placed in the liquid line between the condenser and the evaporator enable the system to operate at maximum efficiency in connection with all installations from 1 ton up to 50 tons. A low-cost, highly efficient line of heat exchangers in a range of standard sizes. Write for catalog 12.

Freon Condensers • Oil Separators • Liquid Receivers • Heat Exchangers • Pipe Coils Forced Convection Units • Hi-Peak Water Coolers • Flooded Water Coolers Ammonia Condensers • Dry-Ex Water Coolers • Evaporative Condensers

ACME PRODUCTS ★★★

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Electrolytic Cleaner

No. 4952—Shop information about "Ferrodex," an electrolytic cleaning compound for ferrous metals and alloys, is given in a four page bulletin of the W. D. MacDermid Chemical Co., Bristol, Conn. Cleaning techniques for metals in various applications are described in this bulletin, which also lists cleaning compounds for non-ferrous metals.

Electronic Controls

No. 4953—Wheelco Instruments Co., Harrison and Peoria Sts., Chicago 7, Ill., has issued a 12 page catalog (Z-6300) on electronic controls, which is designed to supply a convenient, condensed listing of the company's principal items of equipment. It also describes the electronic principle by which control is effected without contact between measuring and control units of an instrument.

Electrostatic Air Cleaner

No. 4954—The first issue of Newsfront, 306 Fourth Ave., Box 1017, Pittsburgh, Pa., Westinghouse monthly, features a story on a new application of the "Precipitron" air cleaner for the removal of fly ash, and a picture page illustrating recent developments of the company. Requests to be placed on the mailing list should be addressed to the Editor, Newsfront, 306 Fourth Ave., Box 1017, Pittsburgh, Pa.

Flow Instruments

No. 4955—An eight page bulletin (318B) of Builders-Providence, Inc., Div. of Builders Iron Foundry, 9 Codding St., Providence 1, R. I., describes "Flo-Watch" flow instruments. Included are specifications for recording instruments; recording and totalizing; recording, totalizing, and indicating; and a universal flow instrument.

Gas Heating Controls

No. 4956—General Controls Co., 801 Allen Ave., Glendale 1, Calif., has announced a new 32 page manual (S1-100) on the application and operation of automatic gas heating controls, with detailed drawings showing specific application of valves on various hook-ups. A feature is a presentation of service troubles that may occur and their remedies.

Heat Transfer Equipment

No. 4957—A 16 page bulletin (645) of the Whitlock Mfg. Co., 100 South St., Hartford 1, Conn., describes the manufacturer's line of heat transfer equipment, including shell and tube and coil types. The bulletin illustrates design considerations pertinent to the chemical processing field, and specifies individual product data including fuel oil heaters, water heaters, and power plant equipment.

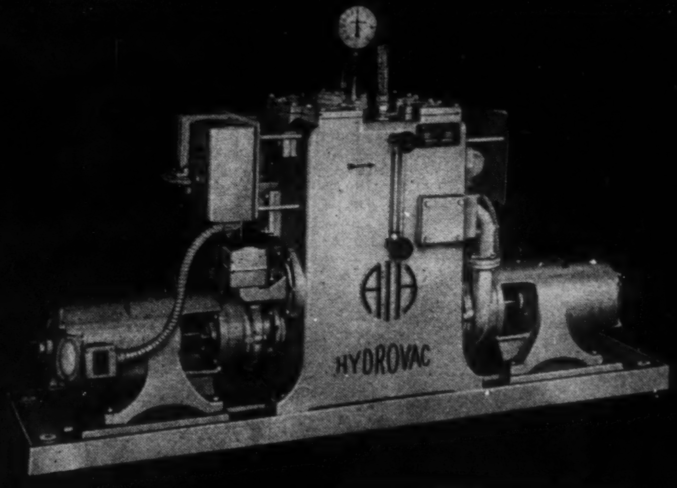
Hot Water Heating

No. 4958—Specialties for "warm water" radiator heating systems and modern water heaters of both tankless and storage tank types are shown and described in a 20 page catalog (D-99) issued by Taco Heaters, Inc., 342 Madison Ave., New York, N. Y. Detailed information is given on the manufacturer's one

3-WAY GUARANTEE OF DEPENDABLE PERFORMANCE

Hydrovac

Super Vacuum Return Units



Not one, not two, but three guarantees highlight the quality and performance of Hydrovac units.

1. 3-year wear-proof guarantee.
2. Guarantee of a minimum of 25 inches of vacuum at 70° F. against a sealed inlet.
3. Guarantee that vacuum will not recede to zero, with unit at rest, in any time under 5 hours.

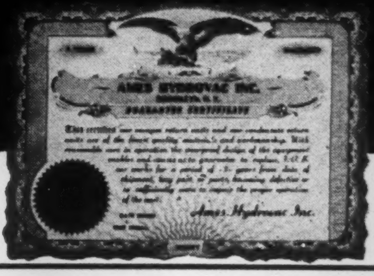
Note these features of Hydrovac's exceptional design and construction:

(1) Permoy Cast Iron Receiver; (2) Bronze Internal Parts; (3) Extra Large Shielded Bearings; (4) No Vacuum at Stuffing Box; (5) All facings machined; (6) Stainless Steel Rods; (7) Dash Pot Mechanical Valves; (8) Stainless Steel Bushings; (9) Wide Clearance Between Working Parts.

Get All the Facts Back of Hydrovac's Triple Guarantee. Write for the 4-page Bulletin 100-B.

AMES HYDROVAC INC.

290 SCHOLES STREET **BROOKLYN 6, N. Y.**



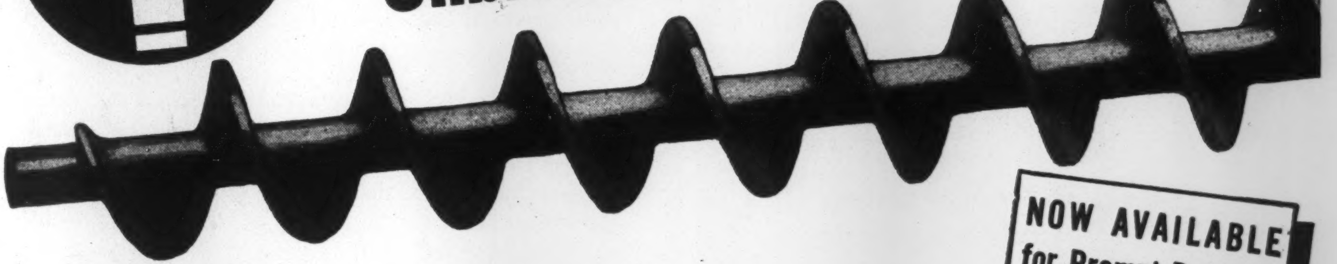
AMES HYDROVAC INC.

GUARANTEE CERTIFICATE

Ames Hydrovac Inc.

For STOKERS

The CROWN Unbreakable Coal Feed Screw



NOW AVAILABLE for Prompt Delivery

WELDED All-Steel Worm—All Sizes—All Pitches

★ Crown's complete line of all-steel Coal Feed Screws meets every replacement and production requirement. Produced for both domestic and industrial stokers. Crown Screws are available with right or left hand screws, in all sizes and pitches, tapered or straight, and in combinations of pitches. Uniformly smooth surfaces insure that coal will flow freely and easily through the flights. Because it is all-steel with continuous weld, the Crown Coal Feed Screw guarantees long, continuous operation with full customer satisfaction. Crown is in a position to make prompt delivery on all sizes.

In ordering give complete specifications on size and design.

CROWN IRON WORKS COMPANY

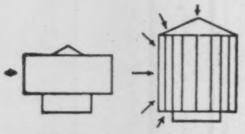
1202 Tyler St., N. E. ***Since 1878*** **Minneapolis, Minn.**

Positive Ventilation
without Down-Draft!

Breidert
Air-X-Hauster
VENT FLUE CAP
The greatest scientific improvement
in Ventilators in over 50 years

Ends annoyance and danger of pilot lights blown out by down-drafts.

No matter which way the wind blows, the revolutionary, aerodynamically correct design of the Breidert Air-X-Hauster enables it to provide safe, sure ventilation. No moving parts . . . "back-draft" eliminated where no interior negative pressure exists! • Unlike conventional ventilators, the Breidert has been thoroughly tested (by Smith, Emery & Co., Pacific Coast branch, Pittsburgh Testing Laboratories) with wind blowing at *all* angles, and its capacities *certified.*

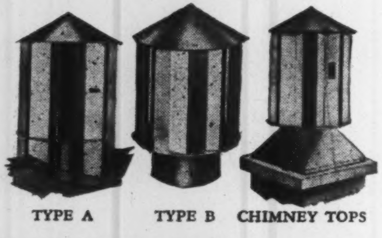


Old Method **Breidert Method**

THE ANSWER TO GAS HEATER PROBLEMS . . . The Breidert does not have the defects of conventional types of caps and accessories. It eliminates the necessity for down-draft diverters, with accompanying dangers of explosion in case unburned gas accumulates or is blown into the room.

Breidert Air-X-Hausters for Roofs and Chimney Tops

There is a Breidert Air-X-Hauster for practically every home, commercial and industrial ventilating problem. Thousands are successfully in use in all parts of the country.



TYPE A TYPE B CHIMNEY TOPS

WRITE FOR FREE ENGINEERING DATA BOOK . . . contains specifications and installation data, certified capacity ratings, etc. Address Dept. S

G. C. BREIDERT CO.
634 South Spring Street, Los Angeles 14, California
REPRESENTATIVES LOCATED IN PRINCIPAL CITIES OF THE U. S.

and two pipe systems of radiator heating, including layout diagrams, design tables, and installation data.

Low Temperature Welding Alloys

No. 4959—A four page folder explaining the specific qualities and uses of low temperature welding alloys, and including a selector chart is offered by the Eutectic Welding Alloys Co., 40 Worth St., New York 13, N. Y.

Mercury Clutches

No. 4960—Mercury Clutch Corp., Canton 6, Ohio, has issued a file of information on its line of clutches, which utilize mercury as a control medium, and which have applications on electric motors and internal combustion engines in connection with air conditioning and refrigeration equipment. The file contains two four page leaflets and several loose leaf sheets.

Mollier Charts for "Freon" Refrigerants

No. 4961—Mollier heat charts, in five colors, for "Freon-12" in the low temperature range, "Freon-22," and "Freon-114" are available on request from Kinetic Chemicals, Inc., 10th & Market St., Wilmington 98, Del. Similar charts for "Freon-11," "Freon-12," "Freon-21," and "Freon-113" were issued in 1940.

Pressure Sealing Zipper

No. 4962—A four page bulletin outlining some of the potential postwar applications of the recently announced "Pressure Sealing" zipper, now going exclusively into military products, has been published by the B. F. Goodrich Co., 548 S. Main St., Akron 18, Ohio. This zipper is an arrangement of overlapping rubber lips applied to a slide fastener to provide an effective seal to any pressures which can be withstood by the structural strength of the fastener. Among potential uses of the zipper given in the publication are pressure ducts, such as those used in commercial dust collectors, which can be tightly sealed and yet allow easy access for maintenance and cleaning; and doorways where dirt, dust, and moisture must be excluded, which can be sealed with this slide fastener.

Pump Book

No. 4963—For the guidance of engineers and servicemen concerned with the operation, purchase, or sale of pumps in the marine, manufacturing, petroleum, and process industries, the Geo. D. Roper Corp., Blackhawk Park Ave., Rockford, Ill., has published a 32 page book on how to solve pumping problems. It outlines the basic steps used in estimating the requirements of the average pumping job. By example and in simple language, it explains the formula used in figuring suction lift. Technical charts and tables show friction loss in pipes, viscosity, viscosity conversion, wiring data, and fuse sizes. Tips on installation and trouble shooting are also included.

Refrigerated Locker Plants

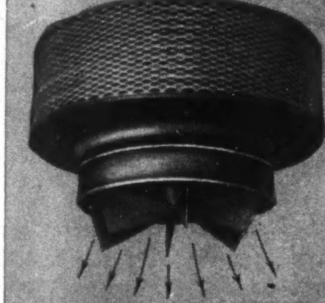
No. 4964—An eight page bulletin (145-F) of the Frick Co., Waynesboro, Pa., is devoted to "Frick-Knickerbocker" refrigerated food locker plants and gives information on cost, service charges, plant arrangement, various types of lockers, key cabinets, etc.

McCORD HEATING AND AIR CONDITIONING PRODUCTS

BLAST HEATING COILS—AIR CONDITIONING COILS—ALL TYPES

All copper spiral fin tube construction with the tubes formed or bent permits uniform expansion without strain. Headers are heavy wall construction with tubes brazed into extended ferrules formed in the headers. Fins are helically wound and metallically bonded. May we send catalog?

VERTICAL TYPE UNIT HEATERS



A proven heating unit, modern in design, incorporating every unit heater advancement. McCord copper spiral fin tube construction creates air turbulence without undue restriction. Improved fan blades deliver large volume of air with minimum air noise. Guaranteed for 150 lbs. saturated steam pressure. Specify McCord.

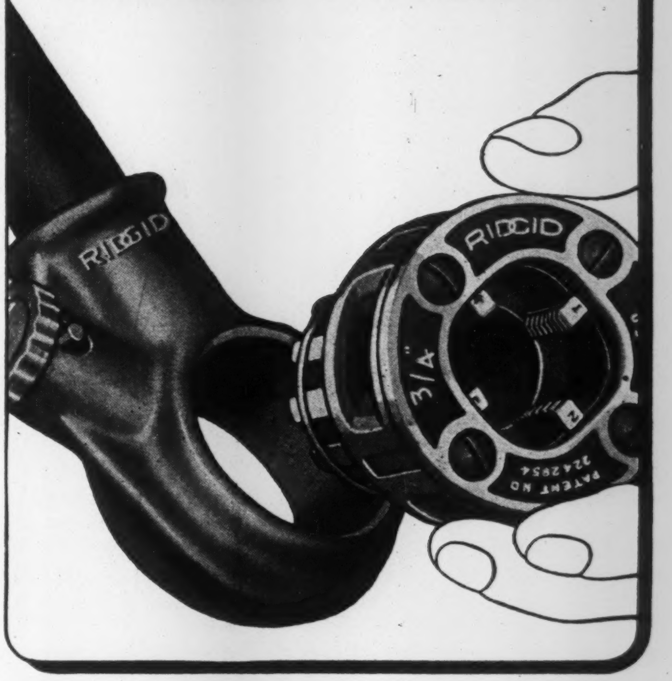
HORIZONTAL TYPE UNIT HEATERS

A time proven heating unit, modern streamlined in design, quiet, yet its rugged construction adapts it to all types of installations, guaranteed for use on No. 150 p. s. i. steam pressure. All copper heating element, individual spiral fin tubes free to expand without strain on joints. Standard motors with standard bases used. Wide range of capacities.

Save fuel with McCord Unit Heaters.

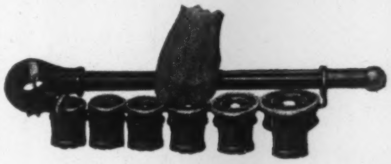
McCord CORPORATION
DETROIT 11, MICH.

You'll enjoy using this smart little RIDGID Ratchet Threader



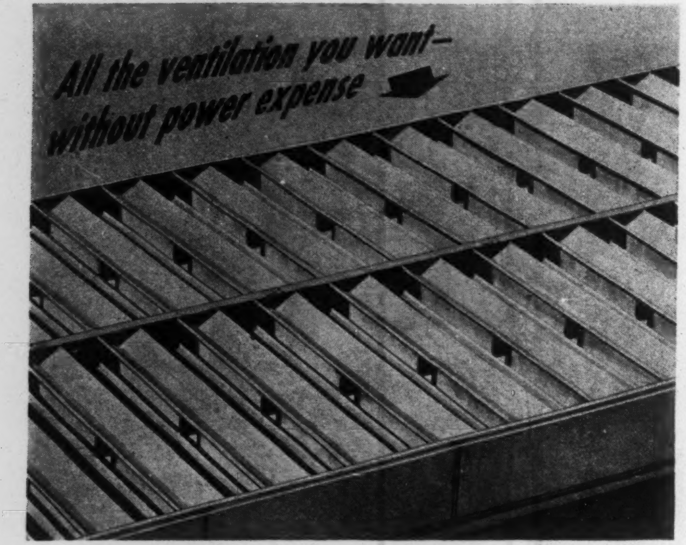
Die Heads lock in either side

● This 111R threader is a time-saver on pipe from ⅛" to 1¼". Click the size die head you want into the ratchet ring, from either side. No special dies needed for close-to-wall threads, just reverse the alloy steel chasers, easily removed also for regrinding. You'll like this efficient rugged little steel-and-malleable threader—ask your Supply House. We're trying our hardest to meet the big demand for RIDGIDs . . . your patience is greatly appreciated.



◀ *Handy carrier with any combination of sizes.*

RIDGID
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL COMPANY • ELYRIA, OHIO, U. S. A.



Swartwout **AIRMOVER**

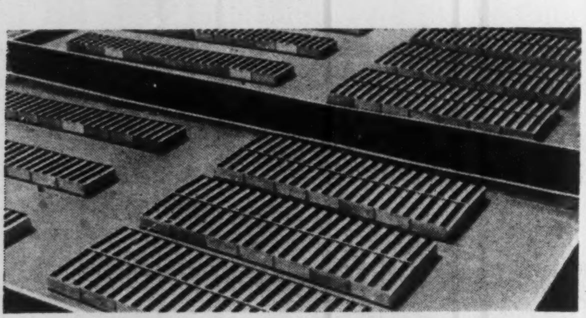
"Open Roof" Method of Industrial Ventilation

Heating and ventilating engineers appreciate its wide application...

● "All the ventilation you want" means enough ventilation to clear workrooms of excess heat, smoke and fumes, gaining the employee comfort that improves morale, promotes efficiency, reduces spoilage and accidents. Swartwout AIRMOVER installations are doing just that in many important factories.

Only 32 inches high, this remarkable modern ventilator spreads over as much of your roofs as necessary, according to the nature of your operations. Uses no power — air flow is *natural* (gravity) with least possible air friction through roof.

Standard units, or custom built to your needs. Easily installed on any type of roof, on old or new buildings. Write for the full story.



LIKE
OPENING
YOUR ROOFS
TO THE SKY

THE SWARTWOUT CO.
18511 Euclid, Cleveland 12, O.

Specialists in Air Movement
by *Natural* Methods

Steam Engineering Film

No. 4965—Yarnall-Waring Co., Chestnut Hill, Philadelphia 18, Pa., has issued an eight page folder describing a 16 mm sound motion picture made by the company. The film, the announcement states, emphasizes the part played in steam engineering by essential auxiliaries such as blowoff valves and steam traps.

Temperature Regulators

No. 4966—The Fulton Sylphon Co., Box 400, Knoxville 4, Tenn., has issued a looseleaf bulletin (820) containing 90 pages of catalog sheets, photographs, and diagrams of the company's line of temperature regulators for heating, ventilating, and air conditioning. The bulletin is thumb-indexed, and space is provided for additional sheets.

Textbook Award Program

No. 4967—A 12 page brochure covering the objectives of an award program for textbooks in modern design, and setting forth all rules governing the program, has been published by the trustees of the James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. The brochure carries explanatory paragraphs dealing with royalties for manuscripts of award winning authors, method of payment of awards, eligibility requirements, bases of judgment in rating papers, and other pertinent facts about the award program.

Underground Pipe Conduit

No. 4968—A four page bulletin (451) on "Therm-O-Tile" conduit for underground pipe lines, published by H. W. Porter & Co., Inc., 825 Frelinghuysen Ave., Newark 5, N. J., covers the four main advantages of this conduit and also shows a modified design for use in exceptionally wet or submerged locations. Specifications are given, and a series of photos show installation steps.

War Work

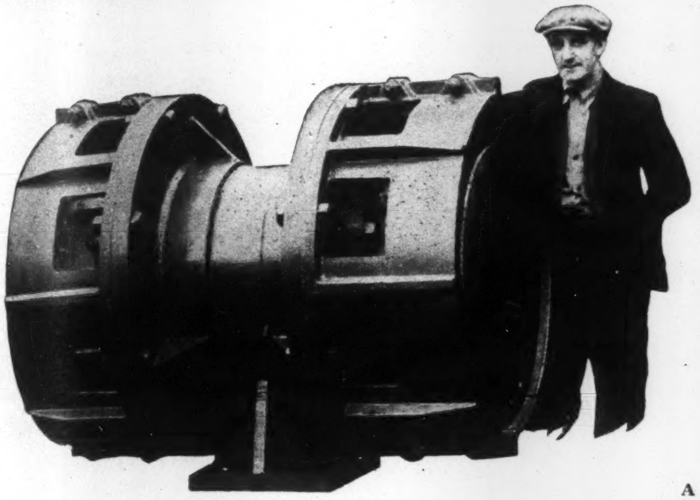
No. 4969—In a four page illustrated bulletin, Lau Blower Co., 2001 Home Ave., Dayton 7, Ohio, reports on its achievement as a producer of goods for the armed forces. The bulletin presents an imposing list of war goods produced by the company, including over one million blowers for all types of military refrigerators.

Welding and Cutting Pipe

No. 4970—A four page illustrated article in the April issue of Oxy-Acetylene Tips, published by the Linde Air Products Co., 30 E. 42nd St., New York 17, N. Y., reports on the production and fabrication of pipe, showing "Unionmelt" welding for making pipe, cutting and beveling pipe by oxy-acetylene equipment, cutting pipe rounds, tube welding, fabricating flanges, reclaiming and altering pipe, double lengthening, fabricating fittings, joining copper tubing, flame straightening, etc.

Welding Lens Chart

No. 4971—A new reference chart for welders, which points out the proper shades of filter lenses to wear for different types of welding operations, has been issued by the American Optical Co., Southbridge, Mass.



ADSCO EXPANSION JOINTS

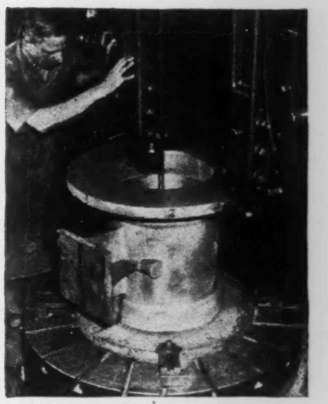
STAY RIGHT because they are MADE RIGHT

This is one of several 24″ ADSCO Internally-Externally Guided Expansion Joints in the Bomber plant of the Ford Motor Car Company, Ypsilanti, Michigan.

Like every other ADSCO Expansion Joint, it is the precision product of expert workmen — a joint built to stay in perfect alignment and give long uninterrupted service. The Piston-Ring Type can even be repacked under full operating pressure without shutting down the line.

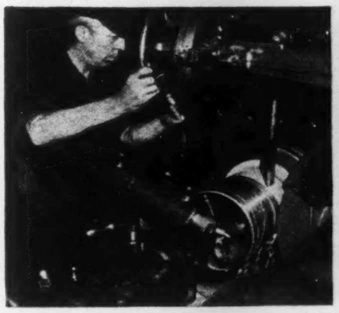
Write for catalog describing the complete line of ADSCO Expansion Joints in sizes from ¾″ — for steam, hot water, gasoline, oil, gas or other pipe lines.

AMERICAN DISTRICT STEAM COMPANY
NORTH TONAWANDA, N.Y.
MAKERS OF "UP-TO-DATE" STEAM LINE EQUIPMENT FOR OVER 65 YEARS.



In every ADSCO Guided Expansion Joint the body is bored on the inside to provide a smooth, true cylindrical bore for the guide ring on the slip.

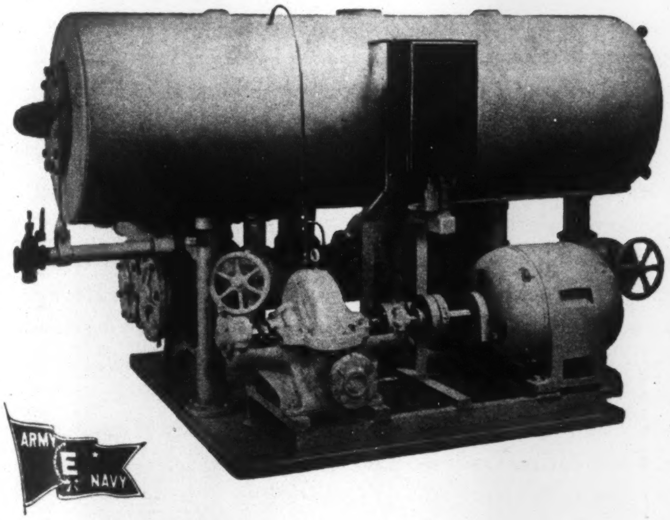
A permanently smooth and true cylindrical slip is important to preserve packing.



All steel slips are ground as shown in photograph then buffed before they are plated to insure a smooth sliding surface against the packing.

ADSCO Expansion Joints are fabricated of wrought steel for high temperatures in fully equipped modern welding shop.

Boiler Feed Pumping Units



A star has been added to the "E" Award for Walter H. Eagan Company's high achievement in the production of Condensate Return Units.

- For use where boiler feed should be controlled by boiler water level.
- Where operation of boiler water make-up condensate return is combined.
- In process steam installations where little condensate is returned.

This is one of the various types of Condensate Return Units manufactured by Walter H. Eagan Co. No matter what your requirements, there is an Eagan Unit to do the job.

Write for General Catalog No. 2
Consult us on your requirements

WALTER H. EAGAN CO.

2336-38 FAIRMOUNT AVENUE, PHILADELPHIA, PA.

Flexibility of Fuel of Growing Importance

Current and future uncertainties about the availability of various types of fuel make fuel flexibility an increasingly important factor in steam generating plants, Alfred Iddles, engineer, of the Babcock & Wilcox Co., New York, said recently at a meeting of the North Texas section of the American Society of Mechanical Engineers.

Discussing boiler design and application, he said that "flexibility in the use of fuel should always be considered and a decision made after an evaluation of the extra cost for the secondary fuel as compared to the probability of that fuel being economically available in the future."

Steam generating equipment which will use various types of fuel is cheaper and safer in the end, he said. The starting point in the selection and design of any steam generating unit is the fuel, he stated. The kind of fuel, its varieties, and variables in the fuel, affect the shape and size of the unit. Sometimes the unit can be used for gas and oil and then used for solid fuels at a lower output, and this might be cheaper than to make a physical change, the speaker stated. The lost capacity could be provided by additional units.

"A unit designed for solid fuel can always be used successfully for gas or oil, but the reverse is not so," he continued. "Sometimes it is feasible to design for gas or oil and make provision for changing the shape or size for coal. This should be done if the chances for use of coal are present but remote. If it is obvious that a solid fuel will be used in a relatively short time, then the unit should be built for those conditions."

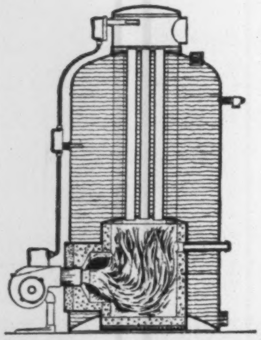
Recalling the confusion of 1943, when by order of the oil administrator, industrial, institutional and dwelling house boiler plants were obliged to convert from coal to oil, Mr. Iddles said:

"Many plants in the Atlantic states were designed for oil only. Those in the same territory that were wisely arranged for burning both oil or coal by the addition of stokers or pulverizers found themselves in a superior position during the war period."

The speaker also emphasized that the complex problems of the steam boiler engineer would be less difficult if buyers and users understood their needs better. The better that both the buyer and user of the equipment and the engineer understand the uses to which it will be put, the better installations can be made.

The address covered modern steam boiler pressures as well as fuels, combustion, and other features. Steam can be supplied to the turbine, the speaker said, at any pressure up to 2500 psi, and any temperature up to 950, and perhaps 1000 F. The trend for larger units, such as utility plants, is in the range of 900 to 1500 psi pressure and 900 to 950 deg temperature. Problems arising from these high steam pressures and the corresponding temperature will be solved by boiler and chemical engineers, Mr. Iddles predicted.

Of steam quality, Mr. Iddles said: "Great strides have been made in the last 10 years in the production of high grade steam. This is one reason why the high pressure and high temperature turbine installations have been successful. The lower quality of steam in the



"Plenty of glamour . . . . but can she cook?"

Questions like that ought to be answered before it's too late . . . whether it's a wife or a dealership you're thinking about.

Glamour wears off just as fast in a dealer-manufacturer partnership as it does in matrimony. After the honeymoon of rosy prophesies is over, you'll find that the real test is a matter of integrity and known performance.

If you are planning to sell heating equipment, we suggest that you check up on the background of Johnson Oil Burners. It isn't just an accident that 75% of the Johnson Burner dealerships we have established in the past 42 years are still active . . . still mutually profitable . . . still mutually cordial.

That simple fact speaks volumes for the quality of our burners and for the way we have always lived up to the spirit as well as the letter of our agreements.

There may be a Johnson dealership open in your territory. We'll gladly tell you.

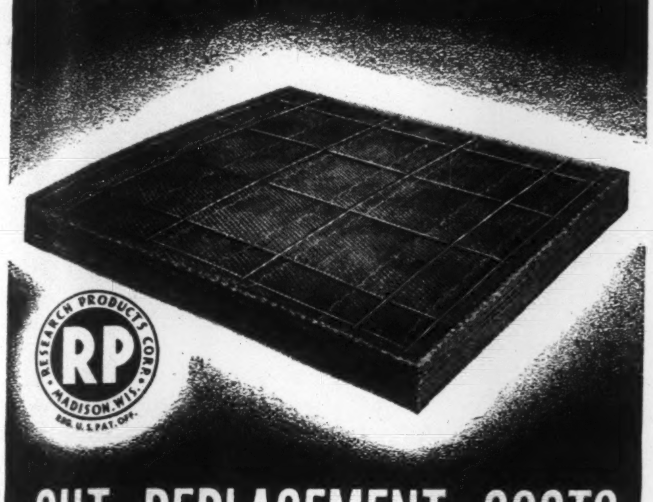
AQULUX WATER HEATERS
are famous for their economy and their enduring efficiency! There's a size for every job.

Johnson Oil Burners

S. T. JOHNSON CO.
940 Arlington Ave., Oakland 8, Calif.
401 No. Broad St., Philadelphia 8, Pa.

Builders of fine Oil Burner Equipment since 1903

STOP MORE DUST

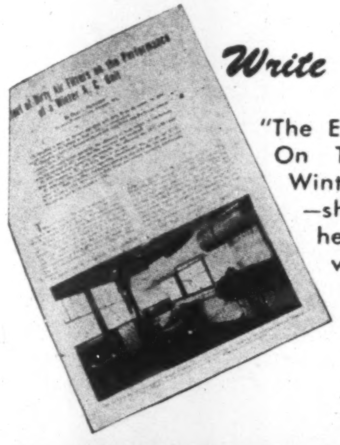


CUT REPLACEMENT COSTS

RESEARCH AIR FILTERS

For Filter Banks and Industrial Dust Collection

HIGH DUST REMOVAL EFFICIENCY—because the air is reversed 21 times in its journey through the Research Air Filter—impinging on more than 30,000 tiny baffles per square foot. LOW RESISTANCE TO AIR FLOW—surface clogging reduced to a minimum.

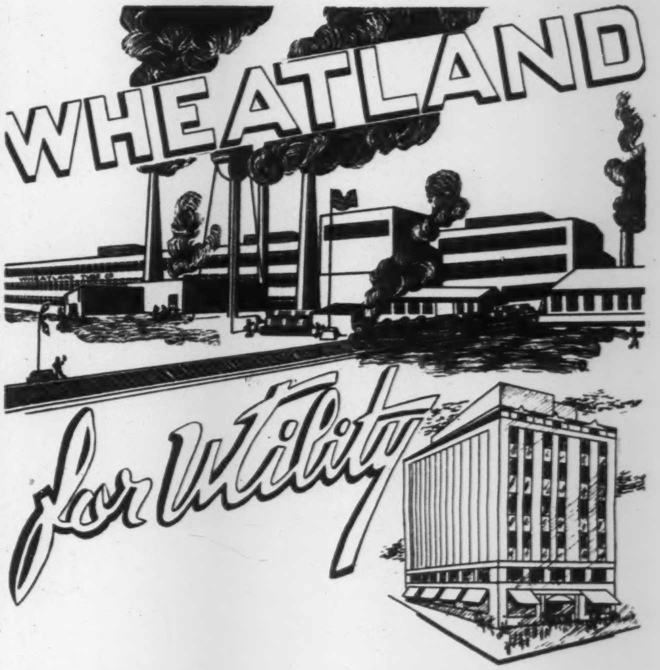


Write For This Study

"The Effect Of Dirty Air Filters On The Performance of A Winter Air Conditioning Unit" —shows how clean filters cut heating costs, increases air volume circulation. Sent free on request, together with technical data sheets. Write today!

RESEARCH PRODUCTS CORP.

MADISON 3, WIS.



OUT at Wheatland, we men in the plant are proud of the pipe we produce. Everyone, from the skelp charger, to the loaders who keep Wheatland pipe moving, knows his job. It's a great big team working together to make each lot better than the one before.

Now when you stop to figure that each fellow at Wheatland is concentrating all his efforts on making steel pipe, it's easy to see why the result is tops. While most specifications call for 700 to 800 lbs., we make ours tough enough to stand up under 1000 lbs. of hydrostatic pressure, assuring you of uniform pipe, perfectly welded.

It's a satisfaction to know our pipe is going into buildings, ships and machines all over the world. That's Wheatland's part in the war, producing sturdy and durable pipe.

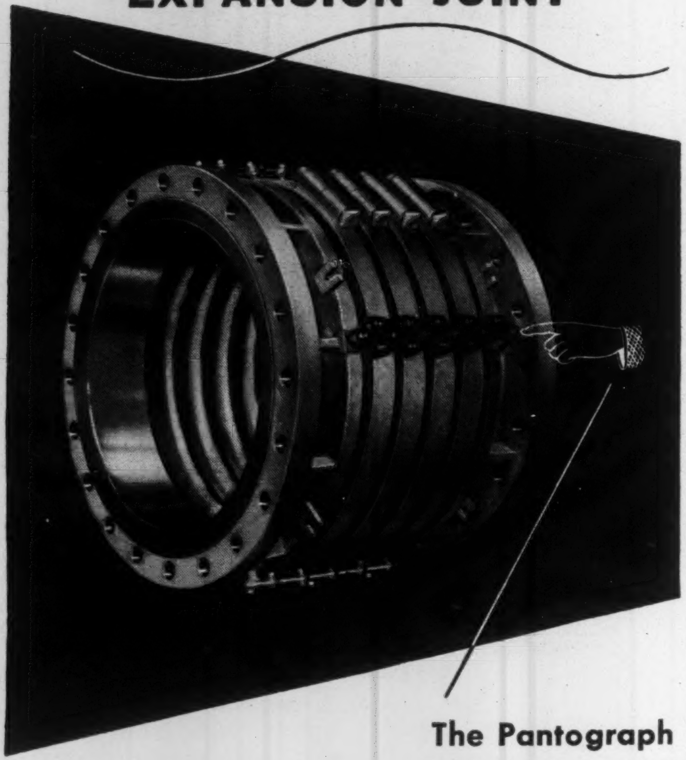
Whether you want black or galvanized, ask your dealer for Wheatland Pipe, and you'll soon discover what we mean by Wheatland "know how".

WHEATLAND 45
—pipe with the yearmark!

Plant: Wheatland, Mercer County, Pa.
General Offices: Real Estate Trust Building
Philadelphia, Pa.

WHEATLAND TUBE COMPANY

Zallea Improved Duo-Equalizing*
EXPANSION JOINT



The Pantograph Chain Does It!

Corrugations of the new Zallea Improved Duo-Equalizing Expansion Joint are positively guided, both under expansion and contraction by two or more pantograph chains. These chains link all corrugations together so that each one must move equally and simultaneously with all others. This new design feature results in an expansion joint which can confidently be relied upon for the maximum possible life for any particular set of operating conditions.

Zallea Improved Duo-Equalizing Expansion Joints can be supplied in sizes from 4″ to 30″ diameter, of copper and many types of stainless steel. For special corrosive applications other metals can be furnished, including Monel, Inconel, nickel and Supernickel. They are built for traverses from a fraction of an inch up to 7½″ in a single unit, for pressures from vacuum to 300 psi, and for temperatures from sub-zero to 1600° F.

Let us quote on your expansion joint requirements. For complete description and specifications of the new Zallea Improved Duo-Equalizing Expansion Joint, write for Bulletin 45.

**U. S. Pat. Pending*

"Code-Craft"...
ZALLEA BROTHERS & JOHNSON
...EQUIPMENT FOR THE PROCESS INDUSTRIES
816 LOCUST ST. • WILMINGTON 99, DEL.

old days would not have been very acceptable to a modern turbine.

"Despite this advance, some form of silica, and in a few number of cases other chemicals, do stop in the various temperature zones of a turbine and cause a decrease in capacity and increase of pressure drop from stage to stage.

"Both the chemist and the equipment designer are working hard to solve this problem and it may be that one or both will be responsible for the next large improvement," he said.

"Incidentally," Mr. Iddles added, "to try to capture a third of a part of something which is circulating around in a million parts of some surrounding gas is a bit difficult."

Gas is the cleanest fuel and oil is next, Mr. Iddles explained. The amount of heat which can be absorbed from either of these fuels, by a given amount of cooling surface, is much greater than can be obtained when burning coal or lignite. This is because of the ash which in some form or other inevitably puts a blanket of insulating material on the tube surfaces through which the heat must pass to the water and steam. A unit to burn coal must, therefore, be larger than one to burn gas or oil.

A few years ago everyone considered oil as substantially as clean a fuel as gas, Mr. Iddles said. This is not always the case now because users are finding that oil fuel in scattered locations is contaminated with certain chemicals and/or ash, so that when burned in a steam unit, a hard, tenacious slag deposit is formed on the heating surface, and especially the superheater. Usually this troublesome slag is almost impossible to remove by chemical means, but it can be dissolved and washed away by water. This condition is not widespread, but is causing severe trouble in certain places and should be guarded against by the proper choice of fuel oil and by the boiler design.

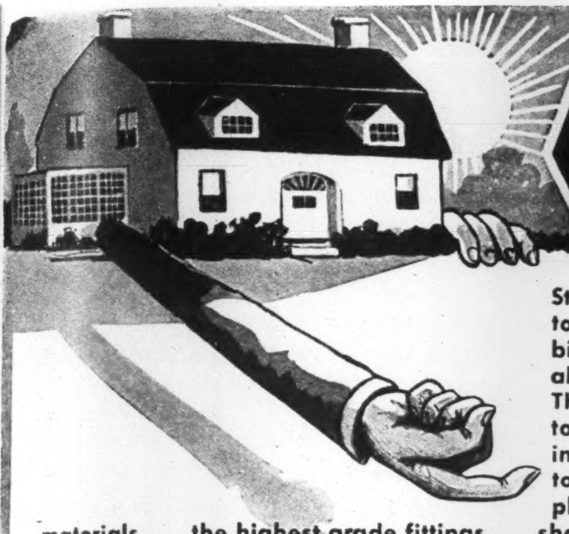
Another trouble which has recently developed in the burning of oil, and in some cases, refinery gas, he said, arises from an increasing amount of sulphur in these fuels. These sulphur compounds produce unusually large amounts of acid with resulting rapid corrosion of the cooler parts of the unit, particularly the air heater.

Economizers and air heaters for such conditions should be especially designed to minimize this corrosion wherever possible.

Asbestos Textile Institute Formed

Recent discussions by a number of asbestos textile manufacturers have led to the formation of the Asbestos Textile Institute, with offices at 12 S. 12th St., Philadelphia 7, Pa. It is a voluntary, nonprofit, unincorporated organization whose function is to render service to manufacturers, to the trade, and to users of asbestos textiles. Membership is open to all individuals, corporations or others in the U. S. who manufacture textiles from raw asbestos fibers. Among the various activities contemplated are the establishment of uniform standards of quality, research to develop new uses and new markets for asbestos textiles.

Technical and general information that will be of interest and value to engineers, designers, manufacturers, and the general public will be prepared and distributed.



"Make Hay While the Sun Shines"

Statistics show that millions of homes and institutions are to be built . . . millions of plumbing systems installed . . . billions of ells, tees and unions used in the years that lie ahead.

That is the plumber's and contractor's golden opportunity to "make hay while the sun shines." Installations that go in smoothly, without waste of time, and with callbacks held to a minimum mean money to the busy contractor and plumber. That's a sound reason why only the highest grade materials . . . the highest grade fittings . . . should be used. "K" fittings make up fast and pull tight. They cause less trouble than ordinary fittings because they are precision cast and thoroughly inspected. Standardize on "K" fittings and save the profits less far-sighted operators dissipate on fittings that so often fail.

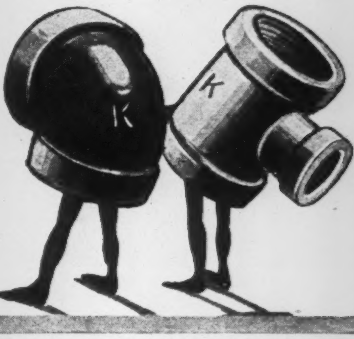
COMPLETE LINE. CATALOG ON REQUEST

- Standard and extra heavy cast iron screwed fittings.
- Standard flanged fittings.
- Standard and extra heavy companion flanges.
- Drainage fittings.

"K" fittings carried in stock at Malleable Iron Fittings Company, Branford, Conn.; M.I.F. stocks at Kuhns Bros. Co., Dayton, Ohio.

KUHNS BROTHERS CO.

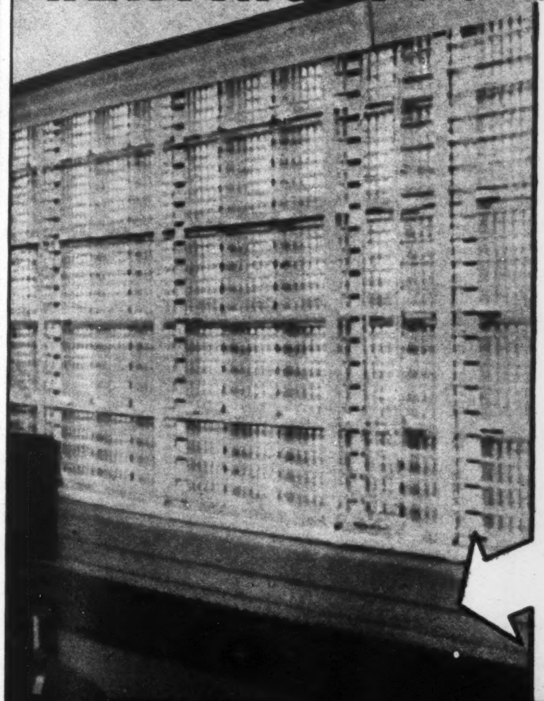
DAYTON 7, OHIO

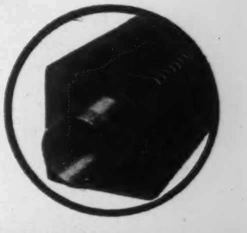


HEATING . . the modern way . . with VULCAN

Along with HUMIDITY CONTROL and AIR CONDITIONING has come MODERN HEATING . . . typified by VULCAN continuous line radiation. Closely spaced fins, permanently fastened (no solder) to heavy walled steel pipe, draw air currents, heat and circulate them gently but adequately throughout the heated area. Such heating by convection allows you to stand within a foot of the radiation without discomfort. Sections are compact, light weight, easy to install, few fittings required. Drafts are eliminated, heat is uniform.

Specify VULCAN . . . Ask for Bulletin.



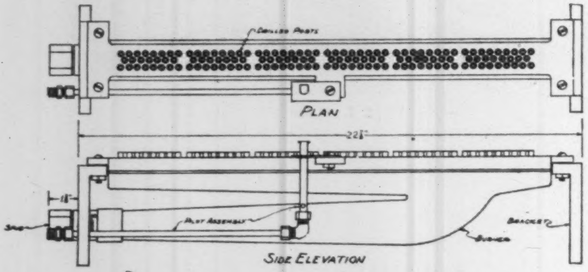


Look for the name
VULCAN—HARTFORD
on every radiator.

Representatives in Principal Cities

THE VULCAN RADIATOR CO. 26 FRANCIS AVENUE, HARTFORD 6, CONN.
RADIATOR MANUFACTURERS FOR ALMOST TWO DECADES

John Zink



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GAS BURNER

Truly a useful and handy burner. Readily portable, easily connected to a gas supply in units of one or more, it is designed to give a maximum of efficient service. There are few low heat requirement services to which it may not be applied with complete satisfaction.

Gas pressure regulators are usually not necessary unless the amount of heat produced by the burner must be held within very close limits hour after hour.

No. 50 Size
$7.00
Add $1.00 if pilot is desired

Recommended Installations of the
UTILITY GAS BURNER

Aluminum Heat Treating Vats . . . Heating Soldering "Irons" . . . Shop and Warehouse Heating Systems . . . Textile Process Heating . . . Foundry Core Drying Ovens . . Process Heating of Metals . . . Small Heating Units in Cold Shop Corners . . . General Laboratory Service . . . Pre-Heating Metals for Welding or Brazing.

The JOHN ZINK UTILITY GAS BURNER really provides "Packaged Heat".

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TULSA, OKLAHOMA
New York - Los Angeles - Detroit - San Francisco - St. Louis

1944 Book of ASTM Standards Issued in Three Parts

The complete new 1944 Book of ASTM Standards, issued in three parts, contains in their latest approved form all of the society's widely used specifications and tests for materials. A most important book in connection with the production, purchase, and use of materials, the latest edition has 1235 specifications and standard methods which cover more than 6000 pages.

All specifications, whether formal standards or tentative are given. The book is issued in three parts, the divisions being as follows:

Part I: *Metals*—Ferrous and nonferrous metals (all A and B and some E serial designations) except methods of chemical analysis. General testing methods (E serial designations).

Part II: *Nonmetallic Materials — Constructional* — Cementitious materials, concrete and aggregates, masonry building units, ceramics, pipe and tile, thermal insulating materials (all C serial designations). Wood and wood preservatives, paints, varnishes and lacquers, road materials, waterproofing and roofing materials, soils (certain D serial designations). General testing methods, thermometers (E serial designations).

Part III: *Nonmetallic Materials—General*—Fuels, petroleum products, electrical insulating materials, rubber, textiles, soaps and detergents, paper, plastics, water (remainder of D serial designations). General testing methods, thermometers (E serial designations).

An innovation in the 1944 book is the inclusion of all emergency standards and emergency alternate provisions which have been widely used to expedite production and procurement of important materials.

(The Society has issued a separate volume on Chemical Analysis of Metals, including standards and recommendations for both ferrous and nonferrous metals. These methods are not included in the Book of Standards.)

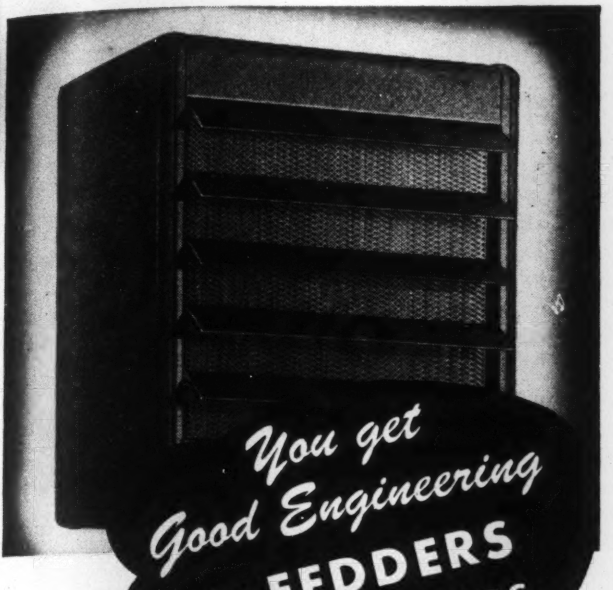
Each part of the 1944 book has a complete subject index (from 36 to 44 pages). There are two extensive tables of contents, the first listing all standards under general materials headings, and the second according to the serial designations of the standards. These features facilitate reference to any subjects covered.

To keep the books up to date, a supplement will be issued to *each* part late in 1945. As a service with the 1944 Book of Standards there is a complete 200 page Index to Standards, which is furnished without additional charge and a copy accompanies the purchase of each part or complete set.

The cost of each part is $10; the charge for supplements is $4 for *each* part, *each* year. For half-leather binding add $1 extra for *each* part and each supplement part. Copies may be obtained from the American Society for Testing Materials, 260 S. Broad St., Philadelphia 2, Pa.

Selective Relaxation of Controls Necessary for Construction Reconversion

Efficient reconversion of the construction industry will require selective relaxation of present government controls at the earliest possible date, followed by their ultimate elimination, in the opinion of the country's



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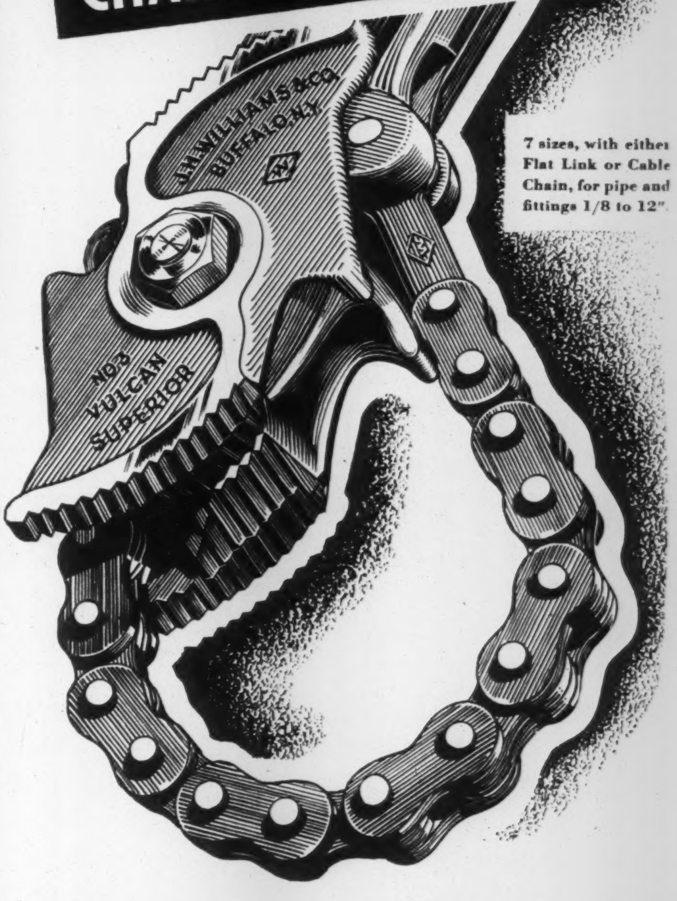

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7 sizes, with either Flat Link or Cable Chain, for pipe and fittings 1/8 to 12".

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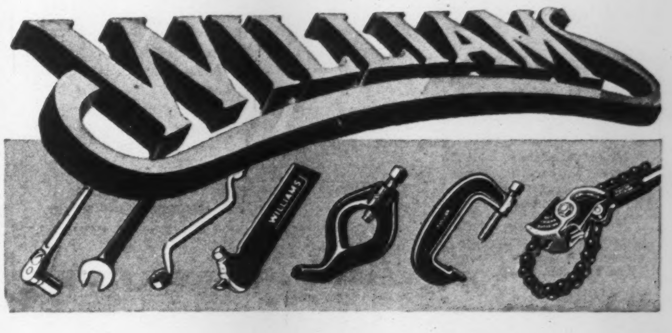


construction industry, the Chamber of Commerce of the United States said last month.

This judgment has been expressed by various segments of the industry, including representatives of designers, contractors, manufacturers and distributors of materials and equipment, and financial and real estate interests. The action was taken at a joint meeting of the construction industry advisory group, which was set up in the fall of 1943, and the construction and civic development committee of the chamber.

To blueprint this complex process, a series of specific recommendations were developed calling for action by the WPB and other government agencies concerned with construction:

a) Rescind WPB orders which restrict manufacture and impose wartime specifications.

b) Allocate adequate critical materials needed to manufacture or produce scarce and missing items.

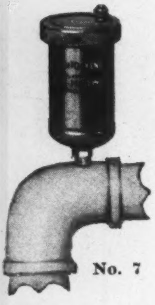
c) Permit manufacturers to utilize required materials and manpower for making of patterns, and reassembly of machinery and other production needs.

d) Priorities assistance to building product manufacturers to do the construction required to readapt or modernize buildings or construct additions or new buildings to provide needed capacity.

e) Priorities assistance to building product manufacturers to obtain additional machine tools or other production machinery.

f) Relax as required the general inventory order to permit wholesalers and retailers to build up inventories to required volume.

GET THAT AIR OUT OF THERE



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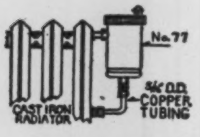
CIRCULATION TROUBLES?

Don't fight air pockets or traps in hot or cold circulating lines! "Get that air out of there" *and keep it out* simply by installing the No. 7 Maid-O'-Mist Automatic Air Vent. This reliable air vent has a self-closing float-controlled valve and is designed especially for circulating pipe lines, convector radiators, unit heaters, cooling manifolds, tanks, diesel engines, or any other application where air pockets or traps retard the free circulation of liquids. For pressures up to 75 lbs. Now available in bright brass finish.



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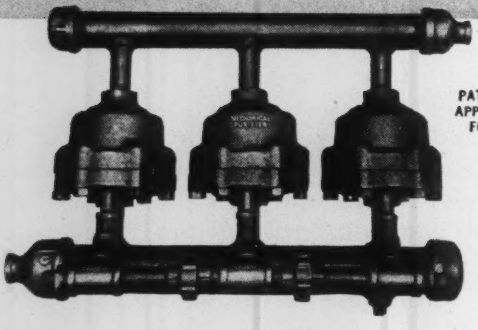
AUTOMATIC HUMIDIFIERS
FOR ALL TYPES OF HEATING SYSTEMS

Purify Any Pressures, Air or Gas, with Bird-White Multiple Unit *Pur-O-fier*



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Model A-1 furnished with a 1 inch turbo-rotor and will accommodate volumes from 1 to 8 cubic feet.

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Bird-White multiple unit Pur-O-fiers save time and money by protecting air-operated machines, gauges and controls from contamination. They give positive purification to air or gas lines regardless of fluctuating pressures or high volumes.

The perfectly balanced Turbo-Rotor purifying action makes them sensitive to both regular and intermittent pressures. Write for Bulletin 10 giving complete details.

BIRD-WHITE COMPANY
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De Luxe type WK Pressure Actuated Water Regulating Valves for Freon, Sulphur or Methyl, are pilot operated, modulating. Standard adjustable opening range from 50 to 150 lbs. Factory set to open at 90 pounds. Precision engineering and individual testing for low cost, satisfactory performance. Available in sizes of 3/4 to 2 inches FPT. Simple adjustment—easily serviced.

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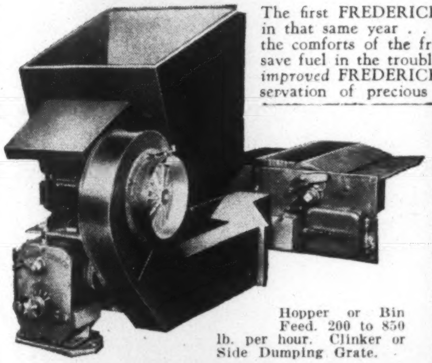

Hopper or Bin Feed. 200 to 850 lb. per hour. Clinker or Side Dumping Grate.

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SIMPLIFIES SELECTION AND APPLICATION OF AIR DIFFUSERS

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All set up in durable loose-leaf binder to facilitate the insertion of supplementary or revised data which will be forwarded from time to time to those who have sent for this catalog. Write for your free copy to Department D3.

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Heat Emission and Friction Heads of Hot Water Radiators and Convectors

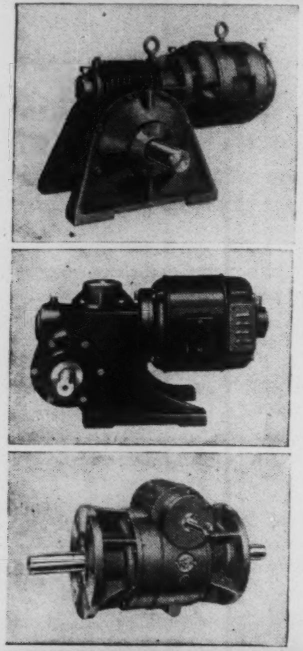
The principal objects of the investigation described in Bulletin No. 356, Heat Emission and Friction Heads of Hot-Water Radiators and Convectors, by Frederick E. Giesecke and Alonzo P. Kratz, which has been issued by the engineering experiment station of the University of Illinois, were to measure the heat emission rates and the friction heads of hot water radiators and convectors of various sizes and forms; and to determine the effect of the following factors on the heat emission rates and friction heads: (1) The type and size of the unit. (2) The size of the pipe connections. (3) The type of the pipe connections. (4) The velocity of the water. (5) The temperature of the water.

A further object was to determine the difference, if any, between the rate of heat emission obtained when either steam or hot water at the same mean temperature was used as the heating medium in connection with the same radiator and convectors.

The radiators tested were small tube radiators of various heights and lengths with different numbers of tubes per section: the convectors tested included one cast iron convector, housed in a cabinet with outlet air grille in the top of the cabinet, and one nonferrous convector housed in a cabinet, with outlet air grille in either the front or the top of the cabinet.

Until August 15, 1945, or until the supply available for free distribution is exhausted, copies of Bulletin No. 356 may be obtained without charge upon application to the Engineering Experiment Station, Urbana, Ill.

Janette



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SPEED
REDUCERS
1/50 to 7 1/2 H.P.
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For SLOW SPEEDS

Janette Speed Reducers offer these outstanding advantages: No jackshafts, pulleys, belts, sprockets, or chains needed. The ratio of speed reduction is positive. Exceptionally low installation cost, because of their compactness. Motors, gears and gear boxes are all Janette built, eliminating divided reponsibility for their successful operation.

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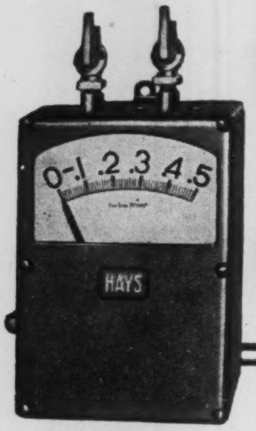

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THIS GAGE TELLS

HAYS AIR-FILTER GAGE

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- EASY TO INSTALL
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If you are confronted with the problem of not knowing when the collected dirt in your filters is of sufficient density to decrease operating efficiency, install a HAYS Air-Filter Gage. The HAYS indicator shows amount of air resistance at all times—tells when to renew filter element—eliminates guess work—can be made to sound alarm when resistance is excessive. Write for full information. Ask for HAYS Bulletin A-F G.

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COMBUSTION INSTRUMENTS AND CONTROL
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ATTENTION
Write today for the complete information which General Blower Co. has prepared for you regarding

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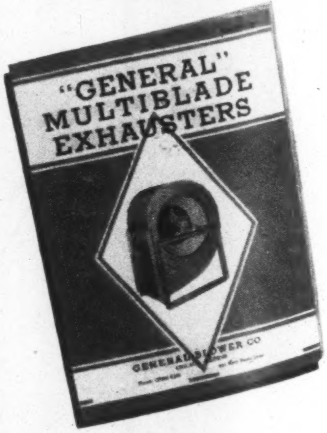

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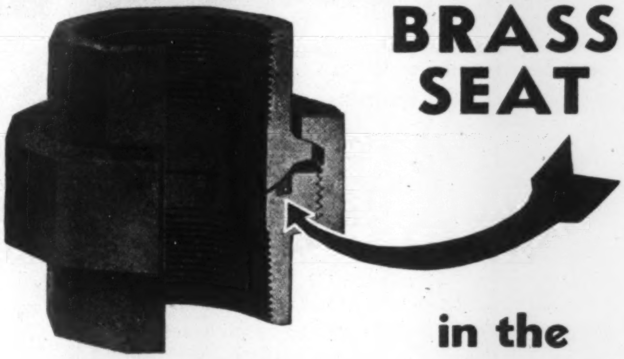

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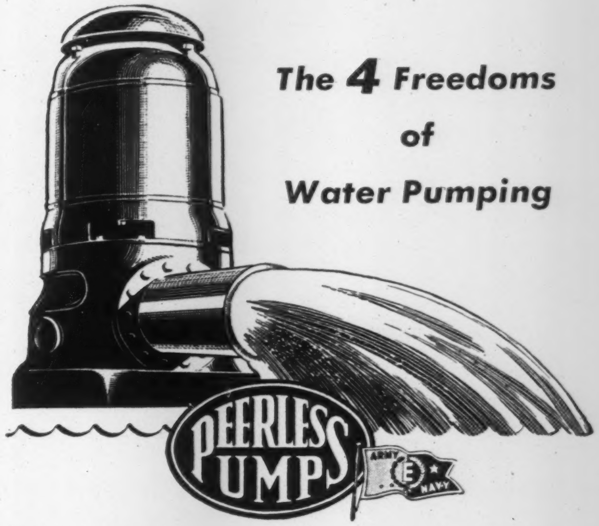

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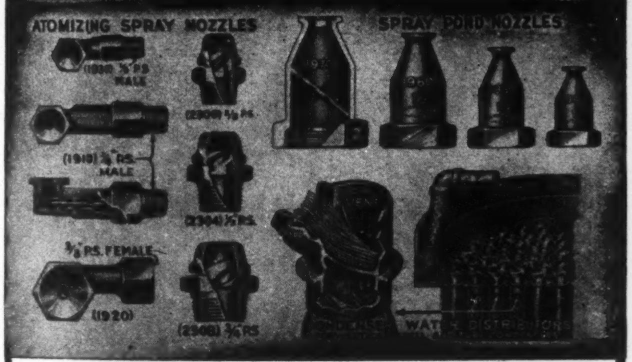

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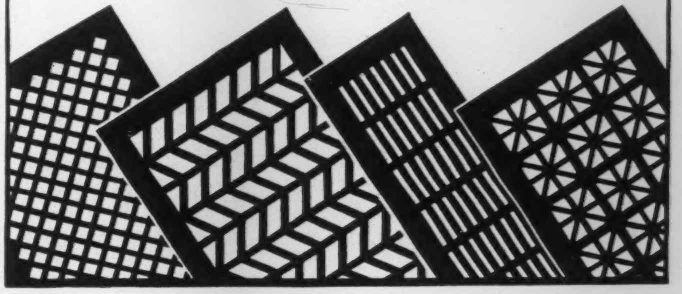

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MEETINGS & CONVENTIONS

ASME Postpones Spring and Semi-Annual Meetings

The executive committee of the council of the American Society of Mechanical Engineers at its meeting on January 26 decided to postpone indefinitely the spring and semi-annual meetings which were scheduled to be held in Boston and Chicago, respectively. This action was taken in order to cooperate with the spirit of the ban on all meetings and conventions issued by the government on account of the railroad transportation emergency. The committee expressed the hope that

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DESIGNED FOR COOLING TOWERS AND EVAPORATIVE COOLERS.
HAS MANY OTHER USES

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Materials corrosive resistant, IRIDITE PLATED. Non Water Absorbing POLYSTERENE FLOAT. Will flow 70 G.P.M. at 20-lb. Pressure, 195 G.P.M. at 80 lbs. Packed in cartons of 12. Usual Trade Discounts.

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Joints sealed with Key-Tite will never leak again, yet can be easily disconnected without damage to threads, fittings, or gaskets.

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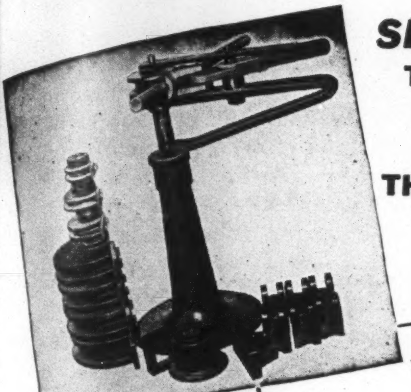

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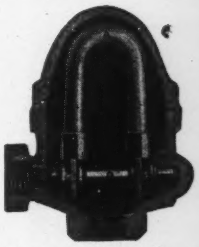
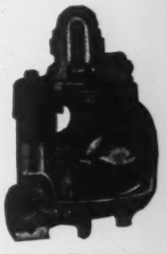


Vento Radiator Trap

The operating member of Haines Traps, the famous Bourdon Thermostatic Tube, is the strongest thermostat ever built into a steam trap.



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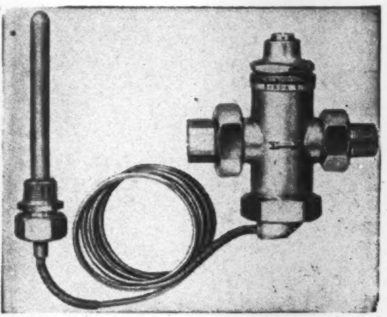

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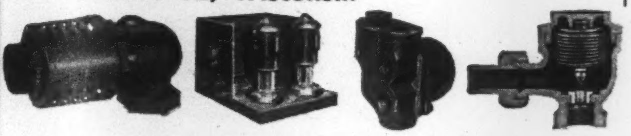
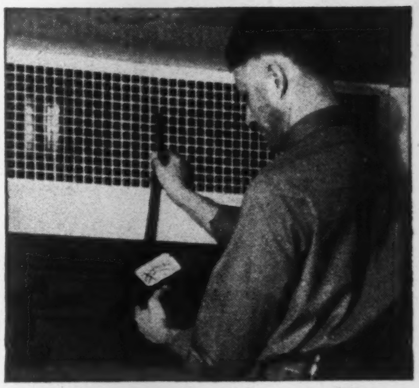


Alnor VELOMETER



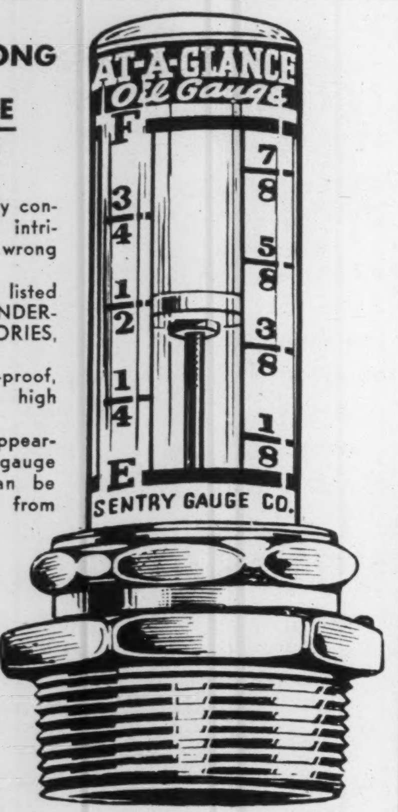
★ all purpose air velocity meter

Instantaneous, direct readings of air speed measured in feet per minute with the *Alnor* Velometer give you the quick, accurate information on air movement needed to check operation of blowers, fans, air conditioning installations, and similar equipment. No calculations, no timing, no conversion tables; read velocities direct from the Velometer scale. Extension jets permit accurate readings in many locations that would be completely inaccessible with other means of measurement.

The Velometer is made in several standard ranges from 20 fpm to 6,000 fpm, and up to 3 inches static or total pressure. Special ranges available as low as 10 fpm and up to 25,000 fpm velocity and 20 inches pressure.

Write for Bulletin No. 2448-E.

Illinois Testing Laboratories, Inc.
419 NORTH LA SALLE STREET • CHICAGO 10, ILLINOIS



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Because:

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4. It is attractive in appearance, and is the only gauge on the market that can be read "AT-A-GLANCE" from any direction.
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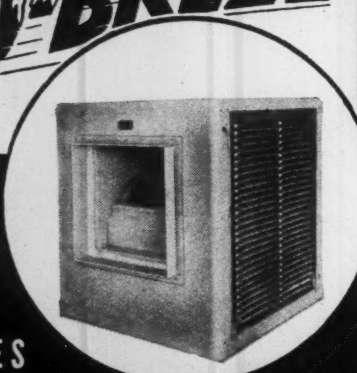

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the various program-making agencies of the society would continue to develop technical papers. Papers which would have been used either at Chicago or at Boston will be made available to local sections for presentation at special local meetings to take the place of the postponed national meetings. Certain papers may be published by the society even though they are not presented at a meeting for discussion.

Refrigerating Engineers Cancel Spring Meeting

The 32nd spring meeting of the American Society of Refrigerating Engineers, originally scheduled for Milwaukee June 11-13, has been cancelled by action of the society's executive committee, in cooperation with the Office of Defense Transportation's order that

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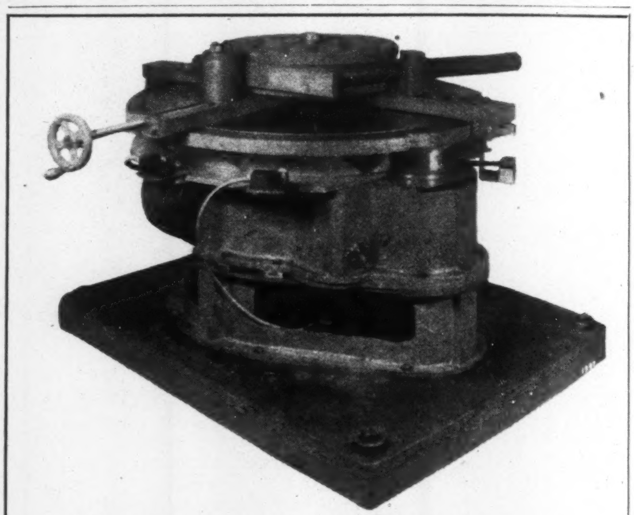

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meetings and conventions be curtailed to ease the wartime load on railroads, air lines, and hotels. The papers scheduled for the meeting are to be published in the society's journal. Although the usual spring meeting will not be held, the ASRE council is to meet June 11 and 12 in Cincinnati at the Hotel Gibson, to transact necessary business.

ASTM Cancels Its Annual Meeting

The executive committee of the American Society for Testing Materials has cancelled the five-day regular annual meeting of the society (scheduled for Buffalo, June 18-22) and instead plans a business session to be held probably the last week in June in New York City. This will permit actions on the formal standards

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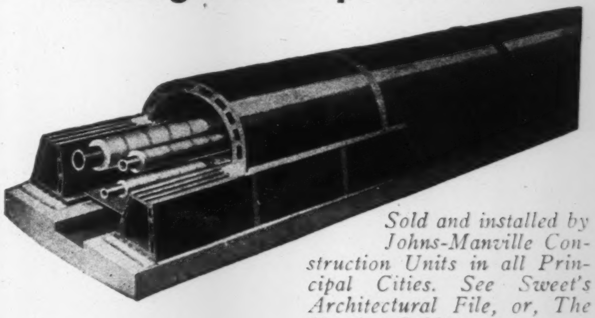

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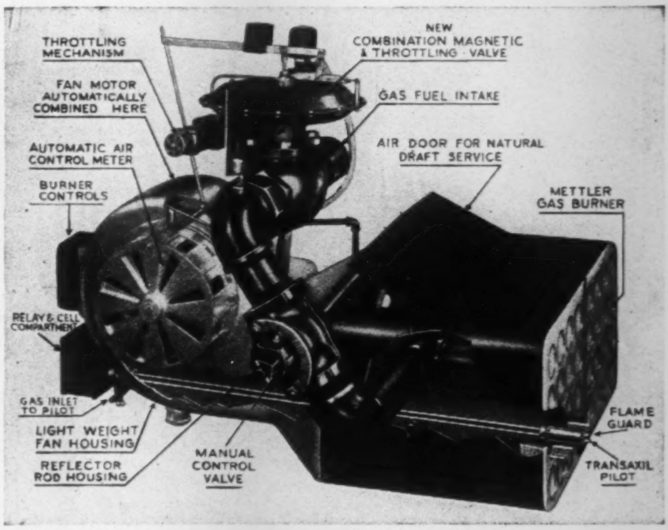
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